imc C-SERIE

Instruction book

Version 2.0 Rev 2 - 03.01.2014

© 2014 imc Meßsysteme GmbH

imc Meßsysteme GmbH • Voltastraße 5 • 13355 Berlin • Germany

Table of contents

imc C-SERIES

1.1 Guide to Using the Manual ... 9
1.2 Guidelines ... 10
1.2.1 Certificates and Quality Management ... 10
1.2.2 imc Guarantee ... 10
1.2.3 ElektroG, RoHS, WEEE ... 10
1.2.4 Product improvement ... 11
1.2.5 Important notes ... 12
1.2.5.1 Remarks Concerning EMC ... 12
1.2.5.2 FCC-Note ... 12
1.2.5.3 Cables ... 13
1.2.5.4 Other Provisions ... 13
1.3 General Notes ... 13
1.3.1 Instruction manual ... 13
1.3.2 Liability limitations ... 14
1.3.3 Guarantee ... 14
1.3.4 Before starting ... 14
1.3.5 Notes on maintenance and servicing ... 14
1.3.6 Safety ... 15
1.3.6.1 Responsibility of the user ... 15
1.3.6.2 Operating personnel ... 15
1.3.6.3 Special dangers ... 16
1.4 Transport and storage ... 17
1.4.1 After unpacking 17
1.4.2 Transporting the device ... 17
1.4.3 Storage ... 17
1.4.4 Cleaning ... 18
1.5 Precautions for operation ... 18
1.5.1 Grounding, shielding ... 18
1.5.1.1 Devices with non-isolated power supply ... 19
1.5.1.2 Devices with isolated power supply ... 19
1.5.1.2.1 Grounding with the use of the included power adapter ... 19
1.5.1.2.2 Grounding with power supplied by a car battery ... 19
1.5.1.3 Shielding ... 20
1.5.1.4 Potential difference with synchronized devices ... 20
1.5.2 Power supply ... 21
1.5.2.1 Main switch ... 22
1.5.2.2 Remote control of the main switch ... 23
1.5.3 UPS ... 24
1.5.3.1 Buffering time constant and maximum buffer duration ... 24
1.5.3.2 Charging power ... 24
1.5.3.3 Take-over threshold ... 24
1.5.4 Rechargeable accumulators and batteries ... 25
1.5.4.1 Lead-gel batteries ... 25
1.5.5 Fuses (polarity-inversion protection) ... 25

Properties of the imc C-SERIES

© 2014 imc Meßsysteme GmbH

2.1 Device Overview 27
2.2 Operating software imc DEVICES and imc STUDIO 28
2.3 Sampling interval 29
2.4 TEDS 29
2.5 Specific parameters 30
2.6 Measurement types 30
2.6.1 Temperature measurement 30
2.6.1.1 Thermocouples as per DIN and IEC 31
2.6.1.2 Pt100 (RTD) - measurement 31
2.6.1.3 imc Thermo connector 31
2.6.1.3.1 Schematic: imc Thermo connector (ACC/DSUB-T4) with isolated voltage channels 32
2.6.2 Bridge measurements 34
2.6.2.1 General remarks 34
2.6.2.2 Bridge measurements with wire strain gauges (WSGs) 34
2.6.2.2.1 Quarter bridge for 120 Ohm WSG 35
2.6.2.2.2 General half bridge 35
2.6.2.2.3 Poisson half bridge 36
2.6.2.2.4 Half bridge with two active strain gauges in uniaxial direction 36
2.6.2.2.5 Half bridges with one active and one passive strain gauge 37
2.6.2.2.6 General Full bridge 37
2.6.2.2.7 Full bridge with Poisson strain gauges in opposed branches 38
2.6.2.2.8 Full bridge with Poisson strain gauges in adjacent branches 38
2.6.2.2.9 Full bridge with 4 active strain gauges in uniaxial direction 39
2.6.2.2.10 Full bridge (Half bridge-shear strain) with two active strain gauges 39
2.6.2.2.11 Scaling for the strain analysis 40
2.6.3 Incremental encoders 41
2.6.3.1 Signals and conditioning 41
2.6.3.1.1 Mode 41
2.6.3.1.2 Event-counting 41
2.6.3.1.3 Time measurements 42
2.6.3.1.4 Combination mode 43
2.6.3.1.5 Differential measurement procedures 44
2.6.3.1.6 Cumulative measurements 44
2.6.3.1.7 Scaling 44
2.6.3.1.8 Comparator conditioning 46
2.6.3.1.9 Single-signal/ Two-signal 47
2.6.3.1.10 Zero pulse (index) 47
2.6.3.2 Mode (events-counting) 48
2.6.3.2.1 Events 48
2.6.3.2.2 Distance 48
2.6.3.2.3 Angle 49
2.6.3.3 Mode (Time measurement) 50
2.6.3.3.1 Time measurement 50
2.6.3.3.2 Pulse Time 51
2.6.3.3.3 PWM 51
2.6.3.4 Mode (combined measurement) 52
2.6.3.4.1 Frequency 52
2.6.3.4.2 Speed 52
2.6.3.4.3 RPM 52
2.6.4 Measurement with current-fed sensors 53
2.6.4.1 Supply current 53

© 2014 imc Meßsysteme GmbH

2.6.5 Overdriving a measurement range ... 54

Device description

3.1 Hardware configuration of all devices ... 55

3.1.1 Digital In- and Outputs, Inputs for Incremental encoders ... 55

3.1.1.1 Digital Inputs ... 55

3.1.1.1.1 Input voltage ... 56

3.1.1.1.2 Sampling interval and brief signal levels ... 56

3.1.1.2 Digital outputs ... 57

3.1.1.2.1 Block schematic ... 58

3.1.1.2.2 Possible configurations ... 58

3.1.1.3 Incremental encoder channels ... 59

3.1.1.3.1 Sensor types, synchronization ... 59

3.1.1.3.2 Comparator conditioning ... 60

3.1.1.3.3 Structure ... 61

3.1.1.3.4 Channel assignment ... 61

3.1.1.3.5 Incremental encoder track configuration options ... 62

3.1.1.3.6 Block schematic ... 62

3.1.1.3.7 Connection ... 63

3.1.1.3.7.1 Connection: Open-Collector Sensor ... 63

3.1.1.3.7.2 Connection: Sensors with RS422 differential line drivers ... 63

3.1.1.3.7.3 Connection: Sensors with current signals ... 64

3.1.2 Analog outputs ... 65

3.1.3 Field bus cabling ... 65

3.1.3.1 CAN-cabling ... 65

3.1.3.1.1 Connecting the terminators ... 65

3.2 Miscellaneous ... 66

3.2.1 Filter settings ... 66

3.2.1.1 Theoretical background ... 66

3.2.1.2 General filter concept ... 66

3.2.1.3 Implemented filters ... 66

3.2.2 ICP-Expansion connector for voltage channels ... 68

3.2.2.1 IEPE (ICP)-Sensors ... 68

3.2.2.2 ICP-Expansion connector ... 68

3.2.2.3 Configuration ICP-connector ... 69

3.2.2.4 Circuit schematic: ICP-connector ... 70

3.2.2.5 ACC/DSUB-ICP2-BNC ... 71

3.2.2.6 ACC/DSUB-ICP2I(M)-BNC ... 72

3.2.3 External sensor supply ... 73

3.2.3.1 External +5 V supply voltage ... 73

3.2.3.2 Sensor supply optional (2.5 V to 24 V) ... 73

3.2.4 DSUB-Q2 charging amplifier ... 74

3.2.5 LEDs and BEEPER ... 75

3.2.6 Modem connection ... 75

3.2.7 SYNC ... 75

3.2.7.1 Optical SYNC Adapter: ACC/SYNC-FIBRE ... 75

3.2.8 IRIG-B module ... 77

3.2.9 GPS ... 78

3.2.10 Operation without PC ... 79

3.2.10.1 Graphical display ... 80

3.3 CS-1016 [-N], CL-1032 [-N] ... 81

3.3.1 Voltage measurement ... 81

3.3.2 Current measurement ... 81

© 2014 imc Meßsysteme GmbH

3.3.3 Current fed sensors ... **81**
3.3.4 Bandwidth ... **81**
3.3.5 Connection ... **81**
3.4 CS-1208-1 [-N], CL-1224-1 [-N] ... **82**
3.4.1 Voltage measurement ... **82**
3.4.1.1 Voltage source with ground reference ... 82
3.4.1.2 Voltage source without ground reference ... 83
3.4.1.3 Voltage source at other, fixed potential ... 83
3.4.1.4 Voltage measurement: With taring ... 83
3.4.2 Current measurement ... **84**
3.4.3 Current fed sensors ... **84**
3.4.4 Bandwidth ... **84**
3.4.5 Connection ... **84**
3.5 CL-2108 ... **85**
3.5.1 High-voltage channels ... **85**
3.5.1.1 Voltage measurement ... 85
3.5.2 Current measurement channels ... **86**
3.5.2.1 Current measurement using Current Probes ... 86
3.5.2.2 Current measurement using Rogowski Coil ... 87
3.5.2.3 Notes on making settings in the imc operating software ... 89
3.5.2.4 Voltage measurement ... 90
3.5.3 Pin configuration and cable wiring ... **91**
3.5.3.1 Notes on the measurement setup ... 91
3.5.4 Connection ... **92**
3.5.4.1 Voltages ... 92
3.5.4.2 Currents ... 93
3.5.4.3 General ... 93
3.5.5 Bandwidth ... **94**
3.6 CS-3008-1 [-N], CL-3016-1 [-N], CL-3024-1 [-N] ... **95**
3.6.1 Voltage measurement ... **95**
3.6.1.1 Input coupling ... 95
3.6.1.2 Case 1: Voltage source with ground reference ... 96
3.6.1.3 Case 2: Voltage source without ground reference ... 96
3.6.2 Bandwidth ... **97**
3.6.3 Connection ... **97**
3.7 CS-4108 [-N], CL-4124 [-N] ... **98**
3.7.1 Voltage measurement ... **98**
3.7.2 Temperature measurement ... **99**
3.7.2.1 Thermocouple measurement ... 99
3.7.2.2 Pt100 (RTD) - Measurement ... 99
3.7.3 Current fed sensors ... **99**
3.7.4 Current measurement ... **100**
3.7.4.1 Current measurement with internal shunt ... 101
3.7.5 Bandwidth ... **101**
3.7.6 Connection ... **101**
3.8 CS-5008-1 [-N], CL-5016-1 [-N], CX-5032-1 [-N] ... **102**
3.8.1 Bridge measurement ... **102**
3.8.1.1 Full bridge ... 103
3.8.1.2 Half bridge ... 103
3.8.1.3 Quarter bridge ... 104
3.8.1.4 Sense and initial unbalance ... 104
3.8.1.5 Balancing and shunt calibration ... 105

© 2014 imc Meßsysteme GmbH

3.8.2 Voltage measurement ... **106**
3.8.2.1 Voltage source with ground reference ... 106
3.8.2.2 Voltage source without ground reference ... 106
3.8.2.3 Voltage source at a different fixed potential ... 107
3.8.3 Current measurement ... **107**
3.8.3.1 Differential current measurement ... 107
3.8.3.2 Ground-referenced current measurement ... 108
3.8.3.3 2-wire for sensors with a current signal and variable supply ... 108
3.8.4 Sensors with current feed ... **109**
3.8.5 Sensor supply ... **109**
3.8.6 Bandwidth ... **109**
3.8.7 Connection ... **109**
3.9 CS-6004-1 [-N], CL-6012-1 [-N] ... **110**
3.9.1 Bridge measurement ... **111**
3.9.1.1 Full bridge ... 112
3.9.1.2 Half bridge ... 113
3.9.1.3 Quarter bridge ... 115
3.9.1.4 Background info on quarter-bridge configuration ... 116
3.9.2 Carrier frequency amplifier: Modulation principle ... **117**
3.9.3 Bandwidth ... **118**
3.9.4 Connection ... **118**
3.10 CS-7008-1 [-N], CL-7016-1 [-N] and CS-7008, CL-7016 ... **119**
3.10.1 Voltage measurement ... **119**
3.10.1.1 Voltage source with ground reference ... 120
3.10.1.2 Voltage source without ground reference ... 120
3.10.1.3 Voltage source at a different fixed potential ... 121
3.10.2 Bridge measurement ... **121**
3.10.2.1 Full bridge ... 122
3.10.2.2 Half bridge ... 122
3.10.2.3 Quarter bridge ... 123
3.10.2.4 Sense and initial unbalance ... 124
3.10.2.5 Balancing and shunt calibration ... 124
3.10.3 Current measurement ... **125**
3.10.3.1 Differential current measurement ... 125
3.10.3.2 Ground-referenced current measurement ... 125
3.10.3.3 2-wire for sensors with a current signal and variable supply ... 126
3.10.4 Temperature measurement ... **127**
3.10.4.1 Thermocouple measurement ... 127
3.10.4.1.1 Thermocouple mounted with ground reference ... 127
3.10.4.1.2 Thermocouple mounted without ground reference ... 128
3.10.4.2 Pt100/ RTD measurement ... 129
3.10.4.2.1 Pt100 in 4-wire configuration ... 129
3.10.4.2.2 Pt100 in 2-wire configuration ... 130
3.10.4.2.3 Pt100 in 3-wire configuration ... 130
3.10.4.3 Probe-breakage recognition ... 130
3.10.5 Current fed sensors ... **132**
3.10.6 Charging amplifier ... **132**
3.10.7 Userdefined characteristic curves ... **132**
3.10.8 Sensor supply module ... **132**
3.10.9 Bandwidth ... **132**
3.10.10 Connection ... **133**
3.11 CS-8008 ... **134**
3.11.1 Voltage measurement ... **134**

© 2014 imc Meßsysteme GmbH

3.11.2 1/3-octave calculation ... 134
3.11.3 Current fed sensors ... 135
3.11.4 Bandwidth ... 135
3.11.5 Connection ... 135

Technical specifications

4.1 General technical specs for all devices of imc C-SERIES ... 136
4.2 Cx-10xx analog inputs ... 139
4.3 Cx-12xx analog inputs ... 141
4.4 CL-2108 general technical data ... 143
4.4.1 Cx-21xx analog inputs ... 143
4.5 Cx-30xx analog inputs ... 147
4.6 Cx-41xx analog inputs ... 149
4.7 Cx-50xx analog inputs ... 153
4.8 Cx-60xx analog inputs ... 157
4.9 Cx-70xx analog inputs ... 161
4.10 CS-8008 general technical data ... 166
4.10.1 C-80xx analog inputs ... 166
4.11 Technical Specs: Features (for all devices of imc C-SERIES) ... 169
4.11.1 Variants ... 169
4.11.2 Digital Inputs ... 170
4.11.3 Digital outputs ... 171
4.11.4 Incremental encoder channels ... 172
4.11.5 Analog outputs ... 173
4.11.6 CAN-Bus Interface ... 174
4.11.7 Synchronization and time base ... 174
4.12 Miscellaneous ... 176
4.12.1 imc Graphics Display ... 176
4.12.2 ACC/DSUB-ICP ICP-expansion plug ... 177
4.12.3 ACC/DSUB-ICP2-BNC ... 178
4.12.4 Technical Specs - ACC/DSUB(M)-ICP2I-BNC ... 179
4.12.5 ACC/DSUB-Q2 ... 180
4.12.6 ACC/DSUB-ENC4-IU connector for incremental sensors with current signals ... 181
4.12.7 ACC/SYNC-FIBRE ... 182
4.12.8 IRIG-B ... 183
4.12.9 SUPPLY Sensor supply module ... 184
4.12.10 WiFi (WLAN) Connection ... 185

Connectors

5.1 Connecting DSUB-15 adapter plug ... 186
5.1.1 Overview of the modules and connectors ... 187
5.2 Metal connector ... 188
5.3 DSUB-15 Pin configuration ... 189
5.3.1 Standard and Universal connector ... 189
5.3.2 Special connector ... 190
5.3.3 TEDS connector ... 191
5.4 DSUB-9 plugs ... 192
5.4.1 CAN-Bus (DSUB-9) ... 192

© 2014 imc Meßsysteme GmbH

5.4.2 Display ... 192
5.4.3 Modem (extern) ... 192
5.4.4 GPS ... 193
5.5 Pin configuration of the REMOTE plug (female) ... 193

Last changes

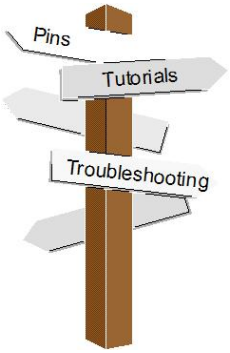
6.1 Error remedies in version (2.0 Rev 2) ... 194
6.2 Error remedies in version (2.0 Rev 1) ... 194
6.3 Error remedies in version (1.0 Rev 13) ... 194
6.4 Additions in version (1.0 Rev 12) what is new? ... 194
6.5 Error remedies in version (1.0 Rev 12) ... 194
6.5.1 Spec sheet history ... 194
6.6 Error remedies in version (1.0 Rev 11) ... 195
6.6.1 Spec sheet history ... 195
6.7 Error remedies in version (1.0 Rev 10) ... 196
6.7.1 Spec sheet history ... 196
6.8 Error remedies in Version (1.0 Rev 9) ... 196

Index 197

© 2014 imc Meßsysteme GmbH

imc C-SERIES

1.1 Guide to Using the Manual



WHERE?	To look for WHAT?	Contents
	You should really read the following chapters!	
Ch. 1	imc C-SERIES	Guidlines and general notes 10
Ch. 1	Properties of im C-SERIES	Expansions and differences 26
Ch. 2	Overview	all devices 27
Ch. 3	Device description	Description of the C-SERIES devices 55
Ch. 4	Technical Specifications	Data Sheets 136
Ch. 4	Connectors	Pin configuration 189

WHERE?	To look for WHAT?	Contents
	You should really read the imc DEVICES manual!	
Ch. 2	Getting Started	Software installation, requirements, settings, update-info
Ch. 3	Operation	Description of the various menu commands and options
Ch. 4	Field bus	CAN-Bus-Interface, J1587-Bus
Ch. 5	Triggers and Events	Triggered/untriggered measurement, pretrigger, oscilloscope mode, multi-shot operation
Ch. 6	imc Online FAMOS	Operation and application tips
Ch. 7	Save Options and Directory Structure	Saving to PC hard disk, saving to the device hard disk, autotrial mode, autostart mode, stand-alone mode, directory structure Sample memory requirement estimation
Ch. 8	µ-Disk, PCMCIA Drive	Features of the µ-Disk & Hot-plug
Ch. 9	Network Options	Synchronized start (Ethernet-) net-bits
Ch. 10	Synchronization with DCF77	Workings, connecting
Ch. 11	Display	Operation and Tutorial
Ch. 12	imcMessaging	Automatic generated messages by the devices
Ch. 13	Miscellaneous	Tips and tricks

Regularly updated information and up-to-date user's manuals can be accessed on www.imc-berlin.com.

1.2 Guidelines

1.2.1 Certificates and Quality Management

imc holds DIN-EN-ISO-9001 certification since May 1995.

You can download an English version of the CE Certification on our Webpage: http://www.imc-berlin.de/unternehmen/qs/ce-konformitaetserklaerung/. Current certificates and information about the imc quality system can be found on the Webpage: http://www.imc-berlin.com in section Customer Support.

For further information, please contact our hotline.

1.2.2 imc Guarantee

Subject to imc Meßsysteme GmbH's general terms and conditions.

1.2.3 ElektroG, RoHS, WEEE

The company imc Meßsysteme GmbH is registered under the following number:

WEEE Reg.- # DE 43368136

Brand: imc DEVICES

Category 9: Monitoring and control instruments exclusively for commercial use

Valid as of 24.11.2005

Our products fall under Category 9, "Monitoring and control instruments exclusively for commercial use" and are thus at this time exempted from the RoHS guidelines 2002/95/EG.

The law (ElektroG) governing electrical and electronic equipment was announced on March 23, 2005 in the German Federal Law Gazette. This law implements two European guidelines in German jurisdiction. The guideline 2002/95/EG serves "to impose restrictions on the use of hazardous materials in electrical and electronic devices". In English-speaking countries, it is abbreviated as "RoHS" ("Restriction of Hazardous Substances").

The second guideline, 2002/96/EG "on waste electrical and electronics equipment" institutes mandatory acceptance of returned used equipment and for its recycling; it is commonly referred to as WEEE guidelines ("Waste on Electric and Electronic Equipment").

The foundation "Elektro-Altgeräte Register" in Germany is the "Manufacturers' clearing house" in terms of the law on electric and electronic equipment ("ElektroG"). This foundation has been appointed to execute the mandatory regulations.

1.2.4 Product improvement

Dear Reader!

We at imc hope that you find this manual helpful and easy to use. To help us in further improving this documentation, we would appreciate hearing any comments or suggestions you may have.

In particular, feel free to give us feedback regarding the following:

- Terminology or concepts which are poorly explained
- Concepts which should be explained in more depth
- Grammar or spelling errors
- Printing errors

Please send your comments to the following address:

imc Meßsysteme GmbH

Voltastraße 5

D - 13355 Berlin

Phone: ☎ 0049 - 30 - 46 70 90 - 26

Fax: 🗐 0049 - 30 - 4 63 15 76

WWW: www.imc-berlin.com

e-mail: hotline@imc-berlin.de

1.2.5 Important notes

1.2.5.1 Remarks Concerning EMC

imc C-SERIES satisfies the EMC requirements for unrestricted use in industrial settings.

Any additional devices connected to imc C-SERIES must satisfy the EMC requirements as specified by the responsible authority (within Europe[2]) in Germany the BNetzA - "Bundesnetzagentur" (formerly BMPT-Vfg. No. 1046/84 or No. 243/91) or EC Guidelines 2004/108/EEC. All products which satisfy these requirements must be appropriately marked by the manufacturer or display the CE certification marking.

Products not satisfying these requirements may only be used with special approval of the regulating body in the country where operated.

All signal lines connected to imc C-SERIES must be shielded and the shielding must be grounded.

Note

The EMC tests were carried out using shielded and grounded input and output cables with the exception of the power cord. Observe this condition when designing your experiment to ensure high interference immunity and low jamming.

Reference

See also *General Notes* \ *Precautions for operation* \ *Grounding, shielding* \ *Shielding*

[2] *If you are located outside Europe, please refer the appropriate EMC standards used in the country of operation.*

1.2.5.2 FCC-Note

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules (CFR 15.105)[3]. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult our imc hotline or an experienced radio or television technician for help.

Modifications

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by imc may void the user's authority to operate this equipment.

[3]*FCC - United States Federal Communications Commission*

1.2.5.3 Cables

Connections to this device must be made with shielded cables with metallic RFI/EMI connector hoods to maintain compliance with FCC Rules and Regulations.

1.2.5.4 Other Provisions

Industrial Safety

We certify that imc C-SERIES in all product configuration options corresponding to this documentation conforms to the directives in the accident prevention regulations in "Electric Installations and Industrial Equipment" (BGV-A3 of the Index of Accident Prevention Regulations of the Professional Guilds in Germany).

This certification has the sole purpose of releasing imc from the obligation to have the electrical equipment tested prior to first use (§ 5 Sec. 1, 4 of BGV-A3). This does not affect guarantee and liability regulations of the civil code.

** formely VBG-4, refer http://www.bgfe.de*

1.3 General Notes

This device has been conceived and designed to comply with the current safety regulations for data processing equipment (which includes business equipment). If you have any questions concerning whether or not you can use this device in its intended environment, please contact imc or your local distributor.

The measurement system has been carefully designed, assembled and routinely tested in accordance with the safety regulations specified in the included certificate of conformity and has left imc in perfect operating condition. To maintain this condition and to ensure continued danger-free operation, the user should pay particular attention to the remarks and warnings made in this chapter. In this way, you protect yourself and prevent the device from being damaged.

Read this manual before turning the device on for the first time! Pay attention to any additional information pages pertaining to the pin configuration etc. which may have been included with this manual.

Warning

Before touching the device sockets and the lines connected to them, make sure static electricity is drained. Damage arising from electrostatic discharge is not covered by the warrantee.

1.3.1 Instruction manual

This instruction manual provides important notes on using the device. The safe working is conditional on compliance with all safety measures and instruction specified.

Additionally, all accident prevention and general safety regulations pertinent to the location at which the device is used must be adhered to.

This instruction manual exclusively describes the device, not how to operate the imc software ! The instructions for the imc measurement software are provided in their own manual. Read carefully the manual before beginning any work!

1.3.2 Liability limitations

All specifications and notes in the operating instruction manual are subject to applicable standards and regulations, and reflect the state of the art well as accumulated years of knowledge and experience.

The manufacturer declines any liability for damage arising from:

- failure to comply with the instructions provided,
- inappropriate use of the equipment,
- additionally, the general terms and conditions of the company imc Mess-Systeme GmbH apply.

1.3.3 Guarantee

Each device is subjected to a 24-hour "burn-in" before leaving imc. This procedure is capable of recognizing almost all cases of early failure. This does not, however, guarantee that a component will not fail after longer operation. Therefore, all imc devices are guaranteed to function properly for two years. The condition for this guarantee is that no alterations or modifications have been made to the device by the customer. Unauthorized intervention in the device renders the guarantee null and void.

1.3.4 Before starting

Condensation may form on the circuit boards when the device is moved from a cold environment to a warm one. In these situations, always wait until the device warms up to room temperature and is completely dry before turning it on. The acclimatization period should take about 2 hours. This is especially recommended for devices without ET (extended environmental temperature range).

We recommend a warm-up phase of at least 30 min prior to measure.

Existing ventilation slits must be kept unimpeded to avoid heat buildup in the device interior.

The devices have been designed for use in clean and dry environments. It is not to be operated in 1) exceedingly dusty and/ or wet environments, 2) in environments where danger of explosion exists nor 3) in environments containing aggressive chemical agents.

1.3.5 Notes on maintenance and servicing

No particular maintenance is necessary.

The specified maximum errors are valid for 1 year following delivery of the device under normal operating conditions (note ambient temperature!).

There are a number of important device characteristics which should be subjected to precise checking at regular intervals. We recommend annual calibration. Our calibration procedure includes calibration of inputs (checking of actual values of parameters; deviations beyond tolerance levels will be reported), a complete system-checkup, newly performed balancing and subsequent calibration (the complete protocol set with measurement values is available at an extra charge). Consult our Hotline for the price for system calibration according to DIN EN ISO 9001.

For devices with UPS functions, we recommend maintenance every 2-3 years.

Please note the hints for rechargeable batteries.

When returning the device in connection with complaints, please include a written, outlining description of the problem, including the name and telephone number of the sender. This will help expedite the process of problem elimination.

For questions by telephone please be prepared to provide your device's serial number and have your imc installation software, as well as this manual at hand, thanks !

The serial number, necessary power supply, interface type and software version included can be

determined from the plaque on the side of the device.

1.3.6 Safety

This section provides an overview of all important aspects of protection of personnel for reliable and trouble-free operation.

Failure to comply with the instructions and protection notes provided here can result in serious danger.

1.3.6.1 Responsibility of the user

The device is for use in commercial applications. The user is therefore obligated to comply with legal regulations for work safety.

Along with the work safety procedures described in this instruction manual, the user must also conform to regulations for safety, accident prevention and environmental protection which apply to the work site.

The user must also ensure that any personnel assisting in the use of the device have also read and understood the instruction manual.

1.3.6.2 Operating personnel

Warning

- **Danger of injury due to inadequate qualifications!**
- Improper handling may lead to serious damage to personnel and property. When in doubt, consult qualified personnel.
- Work which may only be performed by trained imc personnel may not be performed by the user. Any exceptions are subject to prior consultation with the manufacturer and are conditional on having obtained corresponding training.

The instruction manual distinguishes the following degrees of qualification for performing various actions:

- Users of the measurement equipment. Fundamentals of measurement engineering. Recommended: knowledge of foundations of electrical engineering. Familiarity with the Microsoft Windows operating system. Users may not open or modify the device.
- Qualified personnel is able, due to training in the field and to possession of skills, experience and familiarity with the relevant regulations, to perform work assigned while independently recognizing any hazards.

1.3.6.3 Special dangers

This segment states what residual dangers have been identified by the hazard analysis.Observe the safety notes listed here and the warnings appearing in subsequent chapters of this manual in order to reduce health risks and to avoid dangerous situations.

Warning

DANGER!

- Lethal danger from electric current!
- Contact with conducting parts is associated with immediate lethal danger. Damage to the insulation or to individual components can be lethally dangerous.

Therefore:

- In case of damage to the insulation, immediately cut off the power supply and have repair performed.
- Work on the electrical equipment must be performed exclusively by expert electricians.
- During all work performed on the electrical equipment, it must be deactivated and tested for static potential.

Warnung

DANGER!

- Injuries from hot surfaces!
- Devices from imc are designed so that their surface temperatures do not exceed limits stipulated in EN 61010-1 under normal conditions.

Therefore:

- Handles are provided in order to ensure safe operation (for imc CRONOS*flex* systems the handles must be "clicked" the devices).
- Surfaces whose temperature can exceed the limits under circumstances are denoted by the symbol shown at left.

1.4 Transport and storage

1.4.1 After unpacking ...

Check the delivered system immediately upon receiving it for completeness and for possible transport damage.

In case of damage visible from outside, proceed as follows:

- Do not accept the delivery or only accept it with reservations
- Note the extent of the damage on the packing documents or on the delivery service's packing list.
- Begin the claims process.

Please check the device for mechanical damage and/ or loose parts after unpacking it. The supplier must be notified immediately of any transportation damage! Do not operate a damaged device!

Check that the list of accessories is complete:

- 230/110 V AC/DC-supply unit with mains cable
- Printed imc C-SERIES Manual - Getting started
- Manufacturer's Calibration Certificate
- 1x crossed Ethernet network cable and 1 x uncrossed
- 1x LEMO connector (ACC/Power-Plug-1)
- optional: removable hard drive (µ-Disk), GPS receiver, etc.
- DSUB-15 Connectors:
  - 1x ACC/DSUB(M)-DI4-8, 15-pin DSUB clamp connector for 8 digital inputs
  - 1x ACC/DSUB(M)-DO8, 15-pin DSUB clamp connector for 8 digital outputs
  - 1x ACC/DSUB(M)-ENC4, 15-pin DSUB clamp connector for 4 incremental counter inputs
  - 1x ACC/DSUB(M)-DAC4, 15-pin DSUB clamp connector for 4 analog outputs
  - Connector set corresponding to the device's built-in amplifier (see corresponding data sheet)

Note

File a claim about every fault as soon as it is detected. Claims for damages can only be honored within the stated claims period.

1.4.2 Transporting the device

When transporting the device, always use the original packaging or a appropriate packaging which protects the device against knocks and jolts. If transport damages occur, please be sure to contact the imc Customer Support. Damage arising from transporting is not covered in the manufacturer's guarantee.

Potential damage from condensation can be limited by wrapping the device in plastic foil. On this topic, see also the notes under Before commissioning Before starting 14.

1.4.3 Storage

As a rule, the measurement device can be stored at temperatures ranging from -20 to +85°C. Also observe manufacturer’s instructions pertaining to any optional accessories such as internal hard drive, Display, etc.

1.4.4 Cleaning

- Always unplug the power supply before cleaning the device. Only qualified service technicians are permitted to clean the housing interior.
- Do not use abrasive materials or solutions which are harmful to plastics. Use a dry cloth to clean the housing. If the housing is particularly dirty, use a cloth which has been slightly moistened in a cleaning solution and then carefully wrung out. To clean the corners, slits etc. of the housing, use a small soft dry brush.
- Do not allow liquids to enter the housing interior.
- Be certain that the ventilation slits remain unobstructed.

1.5 Precautions for operation

Certain ground rules for operating the system, aside from reasonable safety measures, must be observed to prevent danger to the user, third parties, the device itself and the measurement object. These are the use of the system in conformity to its design, and the refraining from altering the system, since possible later users may not be properly informed and may ill-advisedly rely on the precision and safety promised by the manufacturer.

If you determine that the device cannot be operated in a non-dangerous manner, then the device is to be immediately taken out of operation and protected from unintentional use. Taking this action is justified under any of the following conditions:

I. the device is visibly damaged,
II. loose parts can be heard within the device,
III. the device does not work
IV. the device has been stored for a long period of time under unfavorable conditions (e.g. outdoors or in high-humidity environments).

1. Observe the data in the chapter "Technical Specifications", to prevent damage to the unit through inappropriate signal connection.
2. Note when designing your experiments that all input and output leads must be provided with shielding which is connected to the protection ground ("CHASSIS") at one end in order to ensure high resistance to interference and noisy transmission.
3. Unused, open channels (having no defined signal) should not be configured with sensitive input ranges since otherwise the measurement data could be affected. Configure unused channels with a broad input range or short them out. The same applies to channels not configured as active.
4. For measurement of voltages >60 V, only use banana jacks (4 mm) with contact protection.
5. If you are using a internal device drive, observe the notes in the imc DEVICES / imc STUDIO manual. Particular care should be taken to comply with the storage device’s max. ambient temperature limitation.
6. Avoid prolonged exposure of the device to sunlight.

1.5.1 Grounding, shielding

In order to comply with Part 15 of the FCC-regulations applicable to devices of Class B, the system must be grounded.

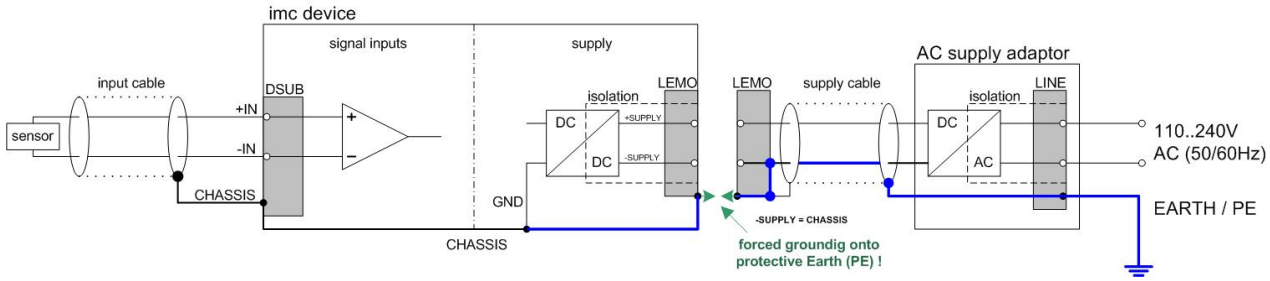
1.5.1.1 Devices with non-isolated power supply

CS Devices and the **CL**-2108 except CS-8008[-N]	The DC-supply input on the device itself (LEMO-plug, female) is not galvanically isolated from the housing (CHASSIS): -SUPPLY input is galvanically connected to CHASSIS internally. That means the device's internal power supply circuitry comprises non-isolating DC/DC converter.

1.5.1.2 Devices with isolated power supply

CL Devices and the **CS**-8008 except CL-2108[-N]	The DC-supply input on the device itself (LEMO-plug, female) is galvanically isolated from the housing (CHASSIS): -SUPPLY input is not connected to CHASSIS internally. That means the decive's internal power supply circuitry comprises isolating DC/DC converter. If the device is powered by an isolated DC-voltage source (e.g. battery), use the device's black grounding socket ("CHASSIS") or the LEMO supply cable's shielding to ground the device.

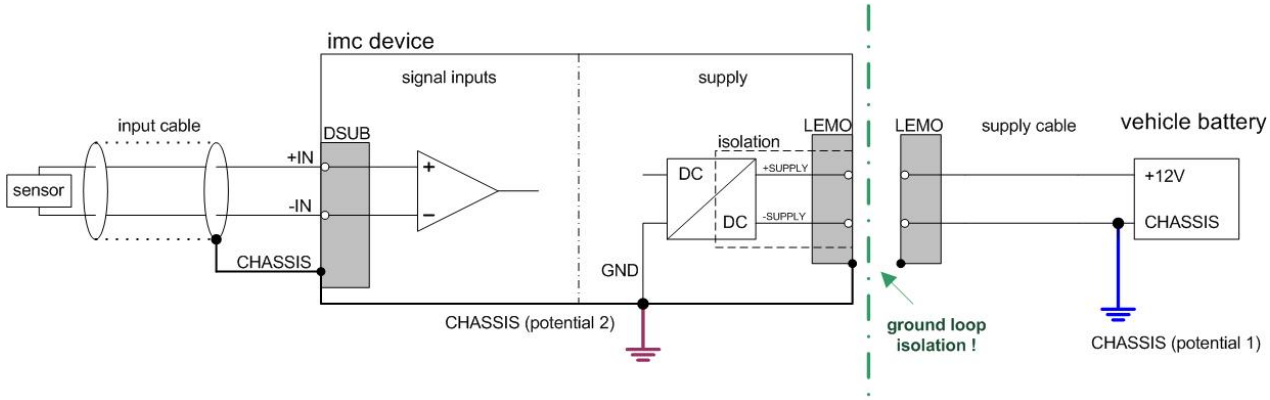
1.5.1.2.1 Grounding with the use of the included power adapter



imc CL Devices and the CS-8008[-N] (exception: CL-2108[-N] 19)

Use of the included table-top power adapter is protected by the power plug's protection ground connection: at the adapter's LEMO terminal, both the (-) pole of the supply voltage as well as the shielding and connector pod are connected with the power cable's protection ground.

1.5.1.2.2 Grounding with power supplied by a car battery



imc CL Devices and CS-8008[-N] (exception: CL-2108[-N] 19) with isolated DC-supply (e.g. battery)

If the power supply (e.g. car battery) and the measurement device are at different voltage levels, then if they were connected by the supply line, it would cause a ground loop. For such cases, the isolated internal device power supply ensures separation of the two voltage levels. The ground reference for the

measurement device must then be established in a separate step.

For running on an isolated DC power supply source (e.g. battery), either the grounding socket terminal, a grounding contact on the device ("CHASSIS"), or the CHASSIS contact on the imc signal connectors must be used.

Isolated power inputs avoids ground loops in distributed topologies

With stationary installations and the use of (already isolated) AC/DC adapters, any system ground differentials between the device and the central or local power supplies may not be relevant. The big issue in such a case, in contrast to mobile, in-vehicle applications, is from where to obtain a reliable ground voltage. Since it is convenient to use the AC power supply's protection ground line as the ground voltage, the LEMO-terminated AC/DC adapters for imc measurement devices are designed so that the protection ground line is connected all the way through to the LEMO connector's housing, thus securing the device's voltage level to protection ground. Additionally, in the AC/DC-adapter's LEMO-terminal (not the device's LEMO-socket!), the reference ground of the power adapter is connected with the housing's (CHASSIS) protection ground: Since the AC/DC power adapter is already isolating, as is the power input, this supply voltage's reference would not initially be defined and can be set arbitrarily. In particular for reasons of suppressing HF (high-frequency) interference signals stemming from the AC/DC switching power adapter, direct grounding is normally advisable.

1.5.1.3 Shielding

Also, all **signal leads** to the device must be shielded and the shielding grounded (electric contact between the shielding and the **plug housing** "**CHASSIS**").

To avoid compensation currents, always connect the shielding to one side (potential) only.If the imc DSUB block screw terminal plug is used, the shielding should be connected to the pull-relief clamp on the cable bushing. This part of the conductor-coated plastic plug housing has electrical contact to the device's housing, just as Terminals 15 and 16 (labeled: "CHASSIS", to the left and right of the imc-plug cable bushing) do; but is preferable to the "CHASSIS" terminals for optimum shielding.

1.5.1.4 Potential difference with synchronized devices

Note

When using multiple devices connected via the **SYNC plug** for synchronization purposes, ensure that all devices are at the same voltage level. Any potential differences among devices may have to be evened out using an additional line having adequate cross section.
If the synchronized devices are at different voltage levels, they should be compensated by means of a lead having the appropriate cross-section. If the SYNC plug at your device is equipped with a yellow ring it is already isolated and it is protected against potential differences (concerning devices as of summer 2012).
Alternatively it is possible to isolate the devices by using the module **ISOSYNC**, see also chapter Synchronization in the imc STUDIO / imc DEVICES manual.

1.5.2 Power supply

Differences between devices of the C-SERIES with serial number (s/n) >14000 [-N] and devices with s/n < 14000 are stated here.

The device is powered by a DC-supply voltage which is supplied via a 2-pin LEMO-plug.

Type designation LEMO plug:

Device	LEMO plug type designation	Size
CS	FGG.**1B**.302 CLAD 76	(middle)
CL	FGG.**0B**.302 CLAD 52ZN	(small)
CX	FGG.**2B**.302.CLAD62Z	(big)

The permissible supply voltage range is 10 ... 32V (DC). The product package includes a corresponding desktop supply unit (15 V DC) as an AC-adapter for mains voltage (110 .. 240V 50/60Hz).

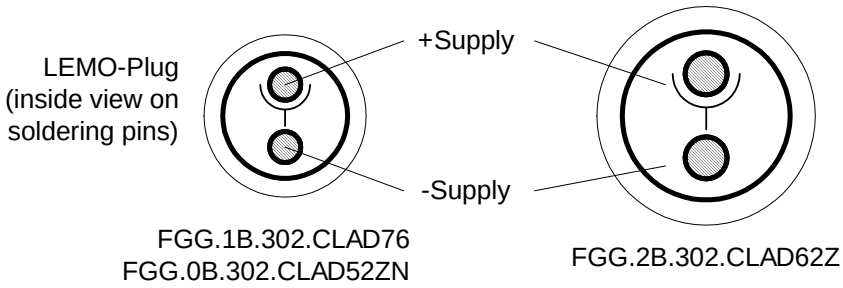
Note

Please note, that the operation temperature of the desktop supply is prepared for 0°C to 40°C, even if your measurement devices is designed for extended temperature range!

The package also includes a cable with a ready-made LEMO-plug which can be connected to a DC-voltage source such as a car battery. When using this, note the following:

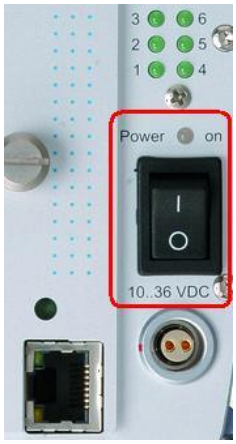
- Grounding of the device must be ensured. If the power supply unit comes with a grounding line, it would be possible to ground the system "by force", by making a connection from this line to the plug enclosure (and thus to the device ground). The table-top power supply unit is made to allow this.
  This manner of proceeding may not be desirable because it may be desirable to avoid transient currents along this line (e.g. in vehicles). In this case the ground-connection must be made to the device directly. For this purpose a (black) banana jack ("CHASSIS") is provided.
- The feed line must have low resistance, the cable must have an adequate cross-section. Any interference-suppressing filters which may be inserted into the line must not have any series inductor greater than 1mH. Otherwise an additional parallel-capacitor is needed.

Pin configuration:

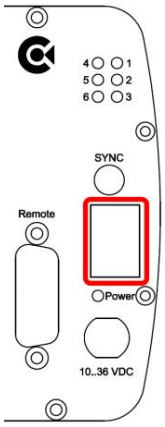


The +pin is marked with a red dot

1.5.2.1 Main switch



CS device



CS-8008[-N]

CX device

CL Device

With the exception of the CS-8008[-N], the main switch of all CS-devices takes the form of a flip switch.

The main switch of the CL-devices and of the CS-8008[-N] takes the form of a rocker switch, which activates the device when it is tipped for approx. 1 second in the "ON" direction.

With the CX devices, a power-On button with a built-in power-LED is the main switch. During operation, the LED shines green. In response to deactivation, and whenever the supply voltage falls below the minimum (power fail), the LED flashes.

Activation

Devices with rocker switch will be activated by clicking for approx. 1 sec the "ON" position. Devices with flip switch will be activated by setting the main switch to the "I" position.
Successful "booting" of the device is confirmed by three short beeps.

- CS- and CX-devices: Upon activation, all 6 status LEDs blink twice.
- CL-devices: There are no LEDs in this device type. Instead the start procedure is seen on the display.

The device is activated

- CS-devices indicate the activated state by the Power LED shining. With a CX-device, the built-in LED shines in the main switch.
- CL-devices indicate the activated state by the Display being on.

Deactivation

Devices with rocker switch will be deactivated by clicking for approx. 1 sec the "OFF" position. Devices with flip switch will be deactivated by setting the main switch to the "O" position.
If the device is running a measurement, it does not deactivate immediately. First, any associated files are closed on the internal hard drive before the device switches off automatically. This process lasts for a maximum of about 10sec. It is not necessary to hold the main switch down for this duration!

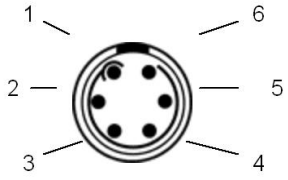
- CS-devices: The deactivation procedure changes the color of the Power LED.

- CX-devices: The deactivation procedure is indicated by regular flashing of the "POWER"-LED.
- CL-devices: The deactivation procedure itself is not indicated. After 10s, the device is completely deactivated and the display switches off.

1.5.2.2 Remote control of the main switch

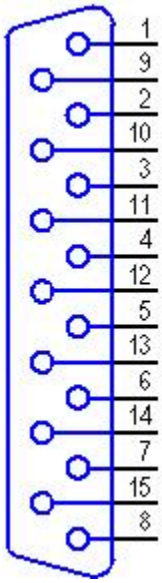
Alternatively to the manual main switch on the device's front panel, it is possible to switch the device on and off by means of an electrical remote control contact. The terminal designated "REMOTE" on the device's rear panel makes this available: either brief or longer connection of the signals "SWITCH" and "ON" activates the device, connecting "SWITCH" with "OFF" switches it off. For the CS-8008, a DSUB-15 socket is the connector, while for CL devices and CX-5032 a LEMO socket is the connector (6-pin FGG.0B.306.CLAD.52Z).

PIN configuration of LEMO plug (FGG.0B.306.CLAD.52Z 6-polig) for CX- and CL



LEMO	Signal	LEMO	Signal
1	OFF	4	SWITCH1
2	SWITCH	5	-BATT (internal testpin)
3	ON	6	-

PIN configuration of the DSUB-15 plug (female) for CS-8008[-N]



DSUB-15	Signal	DSUB-15	Signal
9	OFF	3	SWITCH1
2	SWITCH	11	-BATT (internal testpin)
10	ON		

The signal " SWITCH1" serves to run the device with the switch permanently bridged: when "ON" and "SWITCH1" are connected, the device starts as soon as an external supply voltage is provided.
If this supply is interrupted, the UPS keeps the device activated for the appropriate buffer duration in order to close the measurement and files, and then the device deactivates itself. Starting the device on the internal battery isn't possible in this configuration, but once it has started the device can run on the battery as a backup.
This type of operation is specially designed for use in a vehicle, permanently coupled to the ignition and not requiring manual control.

Any switch or relay contact used for this purpose must be able to bear a current of approx. 50 mA at 10 W max. The reference voltage for these signals is the primary voltage supply.

Possible configurations:

Function	Jumper between
Switch on "normal"	SWITCH and ON
Switch on when connected to main supply only Þ "jumpered main switch "	SWITCH1 and ON
Switch off (switch off within 10 s)	SWITCH and OFF

Pin configuration of the REMOTE plug 193.

1.5.3 UPS

Devices with DC supply input are equipped with an ***uninterruptible power supply*** (UPS). This allows for a continuous operation unaffected by temporary short-term outage of the main power supply. This type of operation is particularly useful for operation in a vehicle, permanently attached to starter lock and main power switch and thus not requiring manual control. Activation of UPS buffering is indicated by the power control LED (PWR) changing from green to yellow. With many imc measurement devices, active UPS buffering is additionally indicated by an acoustic buzzer signal.

The UPS provides backup in case of power outage and monitors its duration. If the power outage is continuous and if it exceeds the specific device's "buffer time constant", the device initiates an automatic shutdown sequence, which equals manual shutdown procedure: Any current active measurement is automatically stopped, data storage on flash card or internal harddisk is completed by securely closing all data files, and finally the device is actually switched off. This entire process may take a couple of seconds.

Thus, a typical application of this configuration is in vehicles, where the power supply is coupled to the ignition. A buffer is thus provided against short-term interruptions. And on the other hand, deep discharge of the buffer battery is avoided in cases where the measurement system is not deactivated when the vehicle is turned off.

If the power failure is not continuous but only temporary, the timer that monitors blackout duration is reset every time the main supply has returned to valid levels. The buffer time constant is a variable device parameter that can be configured according to system size and battery capacity. It can usually be written into the device under software control and is preconfigured to reasonable default values upon delivery (see description in the software manual).

1.5.3.1 Buffering time constant and maximum buffer duration

The ***buffer time constant*** is a permanently configurable device parameter which can be selected as a order option. It sets the maximum duration of a ***continuous*** power outage after which the device turns itself off.

The ***maximum buffer duration*** is the maximum (total) time, determined by the battery capacity, which the device can run on backup. This refers to cases where the self-deactivation is not triggered; e.g., in case of repeated short-term power-interruptions. The maximum buffer duration depends on the battery's current charge, on the ambient temperature and on the battery's age. The device automatically deactivates itself just in time to avoid deep discharge of the battery.

> ☞ **Note**
>
> The buffer time constant can be changed using the operating software imc DEVICES or imc STUDIO.
> see imc DEVICES manual:
> *Chapter 3: Operation > User Interface > Device - menu >Properties...*: Entry *UPS*

1.5.3.2 Charging power

The charging power depends on the device type, its hardware configuration, and the amount and type of rechargeable batteries installed. For this reason, there are a variety of combinations with charging power between 2.4 W and 16 W.

1.5.3.3 Take-over threshold

The voltage threshold at which the storage battery takes over the power supply from the external source is approx. ***9.75 V*** (8.1 V for *CS*). The take-over procedure is subjected to an hysteresis to prevent oscillating take-over. This would be caused by the external supply's impedance. This inevitable impedance lets the external supply rise again, right after take-over to internal buffering. Hysteresis in the take-over threshold will prevent oscillations due to this effect. If, during supply from of the buffering battery, the external supply

voltage rises as high as ***10.9 V*** (9 V for *CS*), the external voltage takes over again from the buffering battery.

If you check these thresholds, note that when the supply voltage is overlaid with a high frequency interference or ripple-voltage, the minima are of key importance. In fact, the overlying interference could be caused by feedback from the device itself!

☞ **Note**

- The voltage specification refers to the device terminals. Please consider the voltage drop of the supply line, when determining the voltage supply.
- **During activation the supply voltage must be above the upper take-over threshold** (≥11 V).

1.5.4 Rechargeable accumulators and batteries

1.5.4.1 Lead-gel batteries

Devices which come with the optional UPS-Function contain maintenance-free lead-gel batteries. Charging these internal backup batteries is accomplished automatically when the activated device receives a supply voltage. Due to the inevitable leakage of charge we recommend that the device be activated for 6 to 9 hours at least every 3 months to prevent the batteries from dying. In case the UPS is used a lot (many discharge and recharge cycles), the life time depends on how much (deep) it has been discharged (is the UPS buffering only for a short time or is the UPS discharged completely every time?). The manufacturer specifies 200 cycles @100% discharging and 1200 cycles @ 30% and 25°C ambient temperature. (that should be true in general for all Pb batteries.)

☞ **Note**	**imc recommend maintenance every 2-3 years.**
	Do not throw the lead-gel accumulators in the household garbage.

1.5.5 Fuses (polarity-inversion protection)

The device supply input is equipped with maintenance-free polarity-inversion protection. No fuses or surge protection is provided here. Particularly upon activation of the device, high current peaks are to be expected. When using the device with a DC-voltage supply and custom-designed supply cable, be sure to take this into account by providing adequate cable cross-section.

Properties of the imc C-SERIES

The imc C-SERIES consists of smart network-capable, unventilated compact measurement devices for all-purpose measurement of physical quantities. These devices can operate either in computer-aided or autonomous mode and are lightweight, compact, and robust, thus, especially well adapted to applications in R&D or in the testing of mechanical and electromechanical components of machines, on board vehicles, or in monitoring tasks in installations.

The most important differences/enhancements of the new devices with the ID code “-N” (suffix) involve functions for networking environments.

Highlights:

- Support of data storage on a network drive (NAS device, hard drive on a network server)
- Can be equipped with a fixed internal WiFi-adapter (Wireless Network, W-LAN)
- Supports synchronization of multiple devices via network protocol NTP (Network Time Protocol), which then replaces the dedicated SYNC-line
- Standard equipped with built-in isolated SYNC signaling (uniformly BNC connectors!), which facilitates operation of multiple devices in distributed setups where ground loops are to be expected, thus in device networking.
- Improved synchronization clock tracking (especially in cases of interrupted GPS reception)

Differences:

- new device group 5 (to date device group 3)
- device serial number range: 14xxxx
- direct CF Card Slot, statt bisher PCMCIA mit mechanischem CF Adapter

The new „-N“ devices now allow fixed installation of an internal W-LAN adapter, offering the following features/advantages:

- rugged solution with robust antenna connection (SMB) tot he device’s front panel suited either for direct antenna connection or cable to independently installed antenna
- simultaneous use of W-LAN and on onboard storage
- supports IEEE 802.11g with 54 Mbit/s transfer rate
- extended temperature range of: -30 .. +85°C

Synchronization

The new „-N“ devices are uniformly equipped with BNC.

Master-Slave synchronization of multiple devices is now more robust and particularly simplified in environments where ground loops are prevalent such as in spatially widely distributed installations: the “-N” devices now come standard with internal galvanical isolation for the SYNC-signal. A yellow marking of the BNC terminal connection indicates isolation of the SYNC signal.

Find here a overview of significant differences 169

2.1 Device Overview

The following table shows all devices. Some of the capabilities discussed in this manual only pertain to certain device models. To see which capability profile your device represents, refer to this table.

— not available ● standard O optional

Device	Interface protocol / Bit/s		Data carrier			RAM Data/ Interface	Rate *	Short description	Distinguishing characteristics
	Std./ Optional	MBit/s	CF**	PCMCIA	Hard drive				
Group 1									
imc µ-MUSYCS	NetBEUI/ TCP/IP	10	—	512MB FAT16	—	1,6 MB/ 64 KB	80 kHz	scanner system with optional amplifiers, DAC, DIO	housing
imc BUSDAQ	NetBEUI/ TCP/IP	10	—	512MB FAT16	—	7,6 MB/ 64 KB	80 kHz	CAN data logger with 2,4 or 6 nodes	housing
imc SPARTAN-L, imc SPARTAN-S	NetBEUI/ TCP/IP	10	—	512MB FAT16	—	7,6 MB/ 64 KB	20 kHz	scanner system with isolated amplifier, DIO (CAN)	housing, markings
imc CRONOS-PL	TCP/IP	10	—	512MB FAT16	—	7,6 MB/ 8 MB	200 kHz	modular system (SPBBF) dated up till Summer, 2003	production date; no LEDs at Ethernet terminal, SN12XXXX
Group 2									
imc CRONOS-PL -2, -3,-4, -8, -13, -16 imc CRONOS-SL -2, -4	TCP/IP	100	—	●	●	14 MB/ 16 MB (32 MB from 2007	400 kHz	modular system (DAB4K) as of Summer, 2003	Production date; two active LEDs at Ethernet terminal, SN12XXXX
Group 3									
imc C1 imc C-SERIES	TCP/IP	100	—	●	—	14 MB/ 32 MB	400 kHz	non modular system	housing, markings, SN12XXXX

Group 1: data access from PC to internal data carrier via the File Manager in imc DEVICES

Group 2-3:data access from PC to internal data carrier via Microsoft Explorer.

* Max.aggregate sampling rate

** We recommend storage media that are tested by imc (please consider the hotline for a current list)

Device table, continued — not available ● standard o optional

Device	Interface protocol / Bit/s		Data carrier			RAM Data/ Interface	Rate *	Short description	Distinguishing characteristics
	Std.	MBit/s	CF**	PCMCIA	Hard drive				
Group 4									
imc BUSDAQ II	TCP/IP	100	●	—	o	16 MB/ 32 MB	400 kHz	field bus data logger	housing, markings, SN13XXXX
imc SPARTAN	TCP/IP	100	●	—	o	16 MB/ 32 MB	400 kHz	modular system	housing, markings, SN13XXXX
Group 5									
imc SPARTAN-R	TCP/IP	100	●	—	o	16 MB/ 32 MB	400 kHz	modular system	housing, markings, SN14XXXX
imc CRONOS compact-400, Base Unit imc CRONOS flex-400	TCP/IP	100	●	—	o	16 MB/ 32 MB	400 kHz	modular system	housing, markings, SN14XXXX
imc miniPOLARES	TCP/IP	100	●	—	—	16 MB/ 32 MB	400 kHz	non modular system	housing, markings, SN14XXXX
imc C1 imc C-SERIES	TCP/IP	100	●	—	—	16 MB/ 32 MB	400 kHz	non modular system	housing, markings, SN14XXXX

Device	Interface protocol / Bit/s		Data carrier			RAM Data/ Interface	Rate *	Short description	Distinguishing characteristics
	Std.	MBit/s	USB**	Express Card	Hard drive				
Group 6									
Base Unit imc CRONOS *flex*-2000	TCP/IP	100	●	●	o	16 MB / 512 MB	2 MHz via EtherCAT else 400 kHz	modular system	housing, markings, SN16XXXX

Group 4-6:
For the purpose of onboard data storage, devices within those groups, are equipped with CF-Card, ExpressCard slot.
Devices within those groups can be equipped with an internally fixed hard drive available as an option.
Data access from PC to internal data storage media via Microsoft Explorer.

* Max.aggregate sampling rate
** We recommend storage media that are tested by imc (please consider the hotline for a current list)

2.2 Operating software imc DEVICES and imc STUDIO

- imc BUSDAQ, imc SPARTAN, imc C-SERIES and measurement devices from the imc CRONOS-series is operated using the operating software imc DEVICES or imc STUDIO. The operating software enables complete manual and automatic setting of the measurement parameters, real-time functions, trigger machines and data saving modes. Display of measurement plots in the curve window and, as well as experiment documentation in the Report Generator, are integral elements of the software. There are extensive triggering options and data storage options adapted to particular applications. Together with the supplementary software imc Online FAMOS, the raw data can be processed in real time to yield the result data in the desired format, and can be displayed.
- imc CANSAS modules can be configured directly from the operating software if the imc CANSAS software is on the same computer. A separate connection from the imc CANSAS module to the PC, e.g.

via a USB-CAN adapter, is not necessary.

- For special tasks such as system integration in test rigs, there are comfortable interfaces for all common programming languages like Visual Basic ™, Delphi ™ or LabVIEW.

2.3 Sampling interval

Among the system's physical measurement channels, up to two different sampling times can be in use. For the possible sampling time see the technical specification in this manual. The **aggregate sampling** rate of the system is the **sum of the sampling rates** of all active channels.

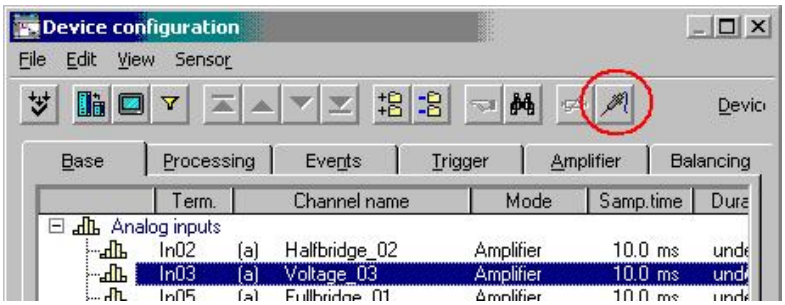
The sampling rates of the **virtual channels** computed by Online FAMOS do not contribute to the sum sampling rate. Along with the (maximum of) two "primary" sampling rates, the system can contain additional "sampling rates" resulting from the effects of certain data-reducing Online FAMOS-functions (ReductionFactor RF).

There is one constraint when selecting two different sampling rates: **Two sampling rates** having the ratio 2:5 and lower than 1ms are not permitted (e.g. 200 µs and 500 µs).

2.4 TEDS

imc Plug & Measure is based on the **TEDS** technology set out in IEEE 1451.4. It fulfills the vision of quick and error-free measurement even by inexperienced use.

TEDS stands for **T**ransducer **E**lectronic **D**ata **S**heet and amounts to a spec sheet containing information about a sensor, a measurement location and the measurement technology used. It is stored in a memory chip which is permanently attached to the sensor, and can be read and processed by the measurement equipment. Besides this, the memory also include a number (unique ID) by which the sensor can be uniquely identified.



A TEDS sensor or a conventional sensor equipped with a sensor recognition memory unit is connected to the device. The sensor recognition contains a record of the sensor's data and the measurement device settings. The device reads this info and sets itself accordingly.

An incorrectly measurement channel is then recognized automatically and marked in different colors. The meaning of the colors is described in manual imc DEVICES chapter *Operation* ⇨ *Settings* ⇨ *Configuration* ⇨ *Sensor TEDS.*

2.5 Specific parameters

There are a number of other parameters to be set which pertain to the specific (analog) conditioning of the measurement channels, and thus come with different (and different amounts of) options to select, depending on the channel group involved. The options are:

- Input range: a variety of ranges depending on the channel type
- Sensor supply
- Filter frequency: low-pass filtering or automatic anti-aliasing filter, corner frequency or options particular to channel type
- Linearization: for thermocouples and PT100 thermistors(for C-41xx and C-70xx)

2.6 Measurement types

2.6.1 Temperature measurement

Temperature measurements can be performed by *CS/CL-41xx* and *CS/CL-70xx*

Two methods are available for measuring temperature.

Measurement using a ***Pt100*** requires a constant current, e.g. of 250 µA to flow through the sensor. The temperature-dependent resistance causes a voltage drop which is correlated to a temperature according to a characteristic curve.

In measurement using **thermocouples**, the temperature is determined by means of the electrochemical series of different alloys. The sensor produces a temperature-dependent potential difference from the terminal in the CAN connector pod. To find the absolute temperature, the temperature of the terminal point must be known. For the Pt1000 this is measured directly in the terminal pod, and therefore an additional type of connector pod is needed.

The voltage coming from the sensor will be converted into the displayed temperature using the characteristic curves according temperature table IPTS-68.

Note on making settings with imc DEVICES

A temperature measurement is a voltage measurement whose measured values are converted to physical temperature values by reference to a characteristic curve. The characteristic curve is selected from the Base page of the imc DEVICES configuration dialog. Amplifiers which enable bridge measurement (e.g.Cx-70), must first be set to Voltage mode (DC), in order for the temperature characteristic curves to be available on the Base page.

2.6.1.1 Thermocouples as per DIN and IEC

The following standards apply for the thermocouples, in terms of their thermoelectric voltage and tolerances:

Thermocouple	Symbol	max. temp.	Defined up to	(+)	(-)
DIN IEC 584-1					
Iron-constantan (Fe-CuNi)	J	750°C	1200°C	black	white
Copper-constantan (Cu-CuNi)	T	350°C	400°C	brown	white
Nickel-chromium-Nickel (NiCr-Ni)	K	1200°C	1370°C	green	white
Nickel-chromium-constantan (NiCr-CuNi)	E	900°C	1000°C	violet	white
Nicrosil-Nisil (NiCrSi-NiSi)	N	1200°C	1300°C	red	orange
Platinum-Rhodium-platinum (Pt10Rh-Pt)	S	1600°C	1540°C	orange	white
Platinum-Rhodium-platinum (Pt13Rh-Pt)	R	1600°C	1760°C	orange	white
Platinum-Rhodium-platinum (Pt30Rh-Pt6Rh)	B	1700°C	1820°C	n.a.	n.a.
DIN 43710					
Iron-constantan (Fe-CuNi)	L	600°C	900°C	red	blue
Copper-constantan (Cu-CuNi)	U	900°C	600°C	red	brown

If the thermo-wires have no identifying markings, the following ***distinguishing characteristics*** can help:

- Fe-CuNi: Plus-pole is magnetic
- Cu-CuNi: Plus-pole is copper-colored
- NiCr-Ni: Minus-pole is magnetic
- PtRh-Pt: Minus-pole is softer

The color-coding of compensating leads is stipulated by DIN 43713. For components conforming to IEC 584: **The plus-pole is the same color as the shell; the minus-pole is white**.

2.6.1.2 Pt100 (RTD) - measurement

Aside from thermocouples, ***RTD (Pt100)*** units can be directly connected in ***4-wire-configuration*** (Kelvin connection). An additional reference current source feeds a chain of up to 4 sensors in series.

With the imc Thermo connector, the connection terminals are already wired in such a way that this reference current loop is closed "automatically".

If fewer than 4 Pt100 units are connected, the current-loop must be completed by a wire jumper from the "last" RTD to -I4.

If you dispense with the "support terminals" (*±I1* to *±I4*) provided in the imc Thermo connector for 4-wire connection, a standard terminal connector or any DSUB-15 connector can be used. The "current loop" must then be formed between *+I1* (DSUB Pin 9) and *-I4* (DSUB Pin 6).

2.6.1.3 imc Thermo connector

The imc Thermo connector ACC/DSUB-T4 contains a screw terminal block in a DSUB-15 connector housing with a built-in temperature sensor (Pt1000) for **cold junction compensation**. This provides for direct connection of thermocouples of any type, directly to the differential inputs (+IN and -IN) without external compensation leads. That connector can also be used for **voltage** measurement.

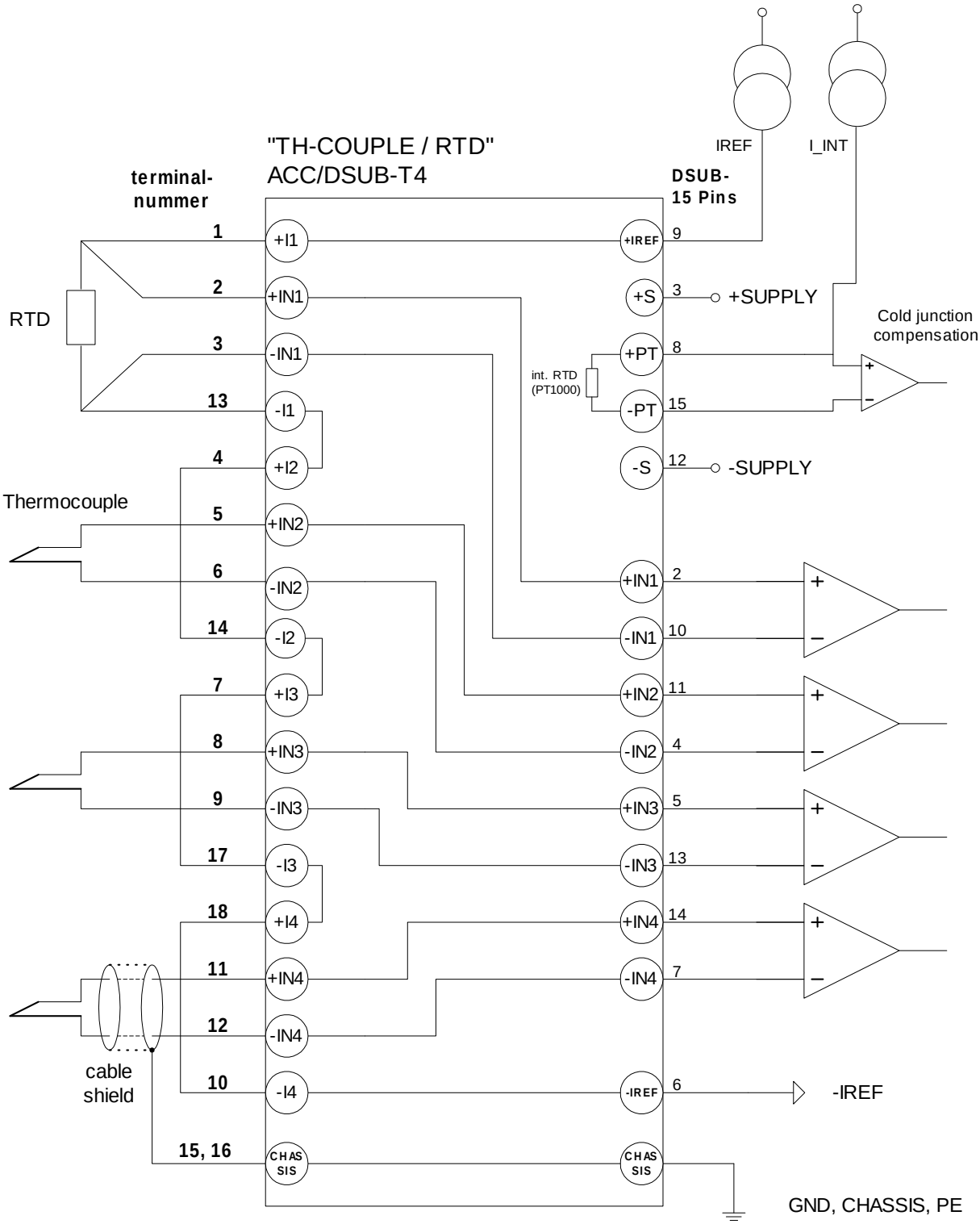
The difficulty with thermocouple measurements are the "parasitic" thermocouples which inevitably form where parts of the contacts made of different materials meet. The temperature sensor measures the temperature at the connection terminal and compensates the corresponding "error"-voltage. Normally,

the connection to this compensation point (inside the device) is made by special compensation leads or connectors made of material identical to the respective thermocouple type, in order not to create additional (uncontrolled) parasitic thermocouples.

imc's system avoids the problem through the use of individual compensation sensors directly inside the connector plug, thus offering an especially simple, flexible and cost-effective connection solution.

Pin configuration of the ACC/DSUB-T4

2.6.1.3.1 Schematic: imc Thermo connector (ACC/DSUB-T4) with isolated voltage channels



2.6.2 Bridge measurements

Bridge measurements can be done with C-50xx, C-50xx-1, C-60xx, C-70xx or C-70xx-1.

2.6.2.1 General remarks

Bridge channels are for taking readings from **measurement bridges** such as resistor bridges or strain gauges. The channels are equipped as **non-isolated differential** amplifiers and can alternatively be used for direct **measurement of voltages**.

There is a distinction among the following operating modes:

1. Target: Sensor
2. Full bridge
3. Half bridge
4. Quarter bridge

- Target: Strain gauge
- Full bridge with 4 active strain gauges in uniaxial direction
- Full bridge with Poisson strain gauge in adjacent bridge arms
- Full bridge with Poisson strain gauge in opposing bridge arms
- Half bridge with one active and one passive strain gauge
- Half bridge with 2 active strain gauges in uniaxial direction
- Poisson half bridge
- Quarter bridge with strain gauge

☞ **Note** The following discussion, whenever it is in reference to terminal connections, circuitry etc., pertains only to the C- 50xx module, and only the most general remarks on bridge measurement are applicable for bridge measurement systems. Such generalized topics include instrument sensitivity and strain gauge properties.

2.6.2.2 Bridge measurements with wire strain gauges (WSGs)

When connecting, observe the notes contained in the sections headed by "Block diagram" and "DC-Bridge measurement (measurement target: Sensor)".

In the context of bridge amplifiers, strain analysis plays a major role. Strain in this sense refers to the ratio of a body's original length to the change in length due to a force exerted upon it.

$$\varepsilon = \frac{dL}{L}$$

By selecting "Strain gauge" as the measurement target on the virtual index card "Inputs", common bridge circuits and configurations for wire strain gauges (WSG) are offered for selection. The scaling can be adjusted in terms of typical parameters for strain measurements such as the gauge factor or Poisson's ratio, the transversal expansion coefficient.

If a WSG adheres to a test object, the strain on the object is transmitted to the bridge circuit. The changes in the lengths of the bridge arms cause their impedances to change. There is a correlation between the changes in length and the changes in resistance:

$$\varepsilon = \frac{dL}{L} = \frac{dR/R}{k}$$

ε *: strain*
dL : change in length
L : original length
dR change in resistance
R : resistance of strain gauge
k : Gauge factor, describing the ratio of relative length change to change in resistance

The changes in resistance caused by the strain are very small. For this reason, a bridge circuit is used to translate these changes into voltage changes. Depending on the circuit, from one to four WSGs can be employed as bridge resistors.

Assuming that all bridge resistors have the same value, we have

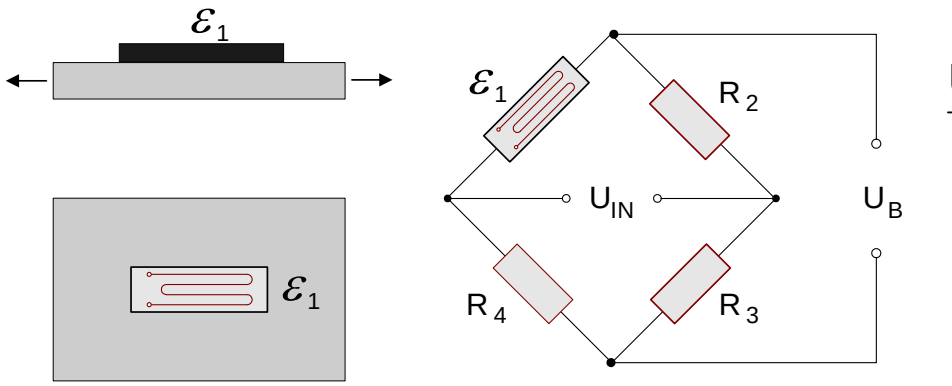
$$Ua = Ue * \frac{dR}{4*R} = \frac{Ue}{4} * k * \varepsilon$$

Ua : measurement voltage; Ue : excitation voltage

$$\varepsilon = \frac{Ua * 4}{Ue * k}$$

For concrete measurement tasks, the arrangement of the WSGs on the test object is important, as well as the circuitry of the bridge. On the card "Bridge circuit", you can select from among typical arrangements. A graphic shows the position on the test object and the bridge circuitry. Notes on the selected arrangement are displayed in the text box beneath.

2.6.2.2.1 Quarter bridge for 120 Ohm WSG



$$\frac{U_{IN}}{U_B} = \frac{K}{4} \cdot N \cdot \varepsilon$$

$$N = 1$$

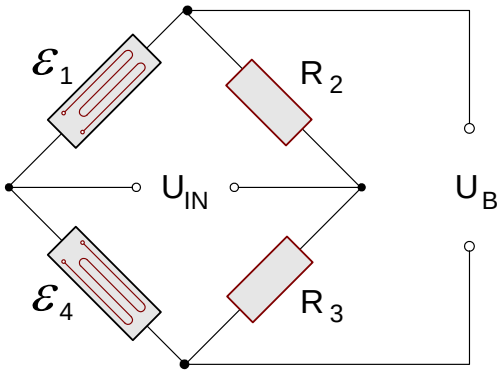
This strain gauge arrangement uses an active WSG which is positioned on the test object in a uniaxial stress field. This WSG is joined by 3 passive resistors within the module to form a full bridge. The strain gauge can have a resistance value of 120 Ω.

This arrangement does not come with temperature compensation. The strain is computed as:

$$\varepsilon[\frac{\mu m}{m}] = \frac{4*1000}{k} * \frac{Ua}{Ue} \; [\frac{mV}{V}]$$

k: gauge factor

2.6.2.2.2 General half bridge

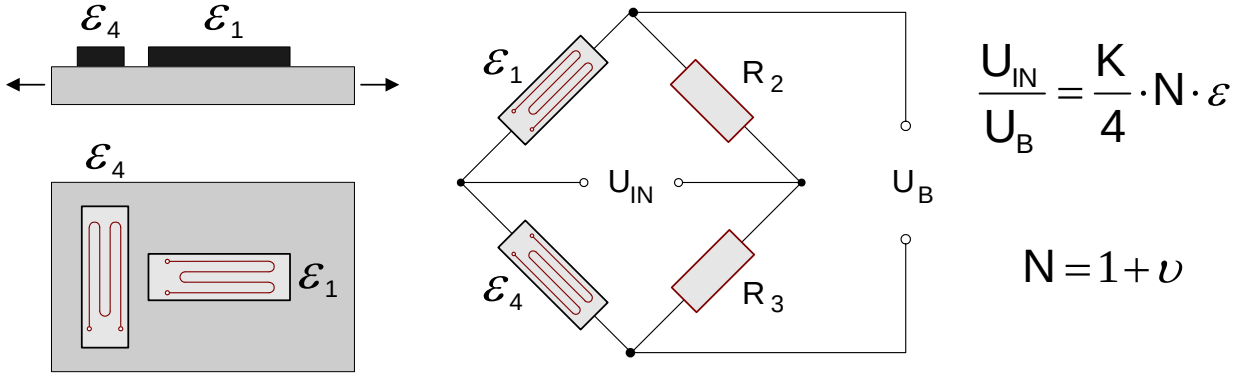


$$\frac{U_{IN}}{U_B} = \frac{K}{4} \cdot N \cdot \varepsilon$$

$$N = 1, 2, 4,$$
$$1-\upsilon, 1+\upsilon$$

General half bridge with bridge completion in measurement device. N has to be set from a list.

2.6.2.2.3 Poisson half bridge



$$\frac{U_{IN}}{U_B} = \frac{K}{4} \cdot N \cdot \varepsilon$$

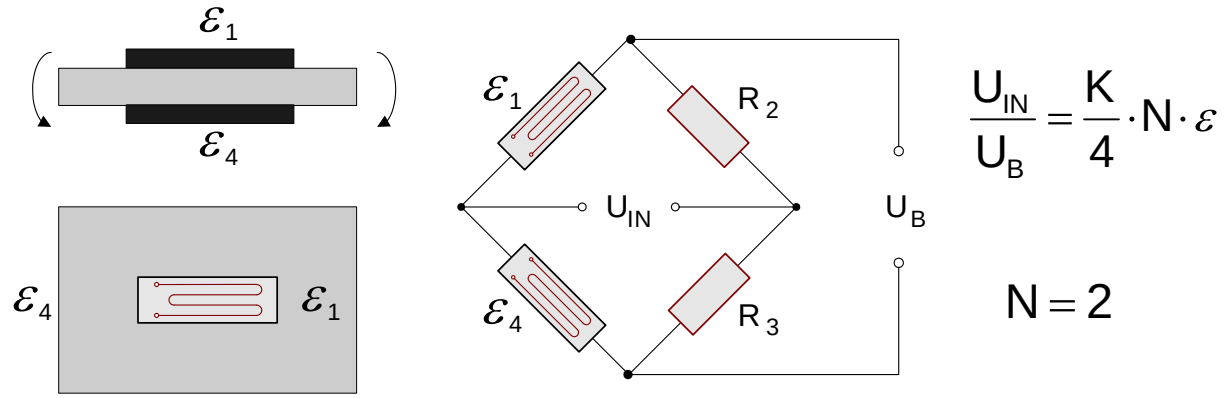
$$N = 1 + \upsilon$$

In this circuit, 2 active WSGs are used. The WSG is positioned transverse to the main direction of strain. The transversal contraction is exploited. For this reason, the Poisson's ratio for the material, which is its transversal expansion coefficient, must be supplied along with the gauge factor. This circuit offers good temperature compensation. The strain is computed as:

$$\varepsilon[\frac{\mu m}{m}] = \frac{4 * 1000}{k * (1 + \nu)} * \frac{Ua}{Ue} \quad [\frac{mV}{V}]$$

k: gauge factor
ν: Poisson's ratio of test object material

2.6.2.2.4 Half bridge with two active strain gauges in uniaxial direction



$$\frac{U_{IN}}{U_B} = \frac{K}{4} \cdot N \cdot \varepsilon$$

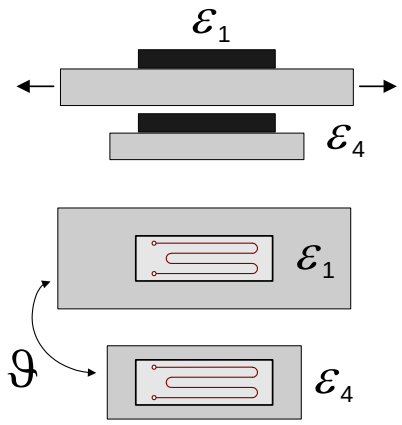
$$N = 2$$

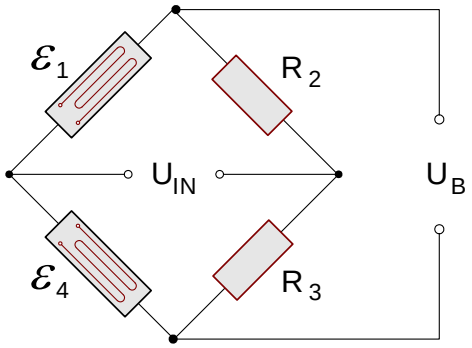
Two active strain gauges are placed under stress in opposite directions but equal magnitude, i.e. one strain gauge is under compression and another under equal tension. (bending beam circuit). This arrangement doubles the measurement's sensitivity to a bending moment. On the other hand, longitudinal force, torque and temperature are all compensated for. The strain is computed as:

$$\varepsilon[\frac{\mu m}{m}] = \frac{4 * 1000}{2 * k} * \frac{Ua}{Ue} \quad [\frac{mV}{V}]$$

k: gauge factor

2.6.2.2.5 Half bridges with one active and one passive strain gauge





$$\frac{U_{IN}}{U_B} = \frac{K}{4} \cdot N \cdot \varepsilon$$

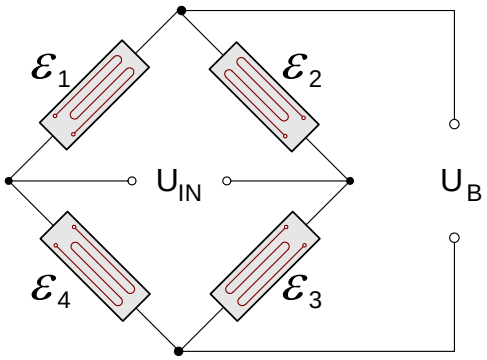
$$N = 1$$

This circuit involves WSGs. The first one is positioned on the test object, the second on a sample of the same material under the same ambient temperature and serves the purpose of temperature compensation. The strain is computed as:

$$\varepsilon[\frac{\mu m}{m}] = \frac{4 * 1000}{k} * \frac{Ua}{Ue} \; [\frac{mV}{V}]$$

k: gauge factor

2.6.2.2.6 General Full bridge

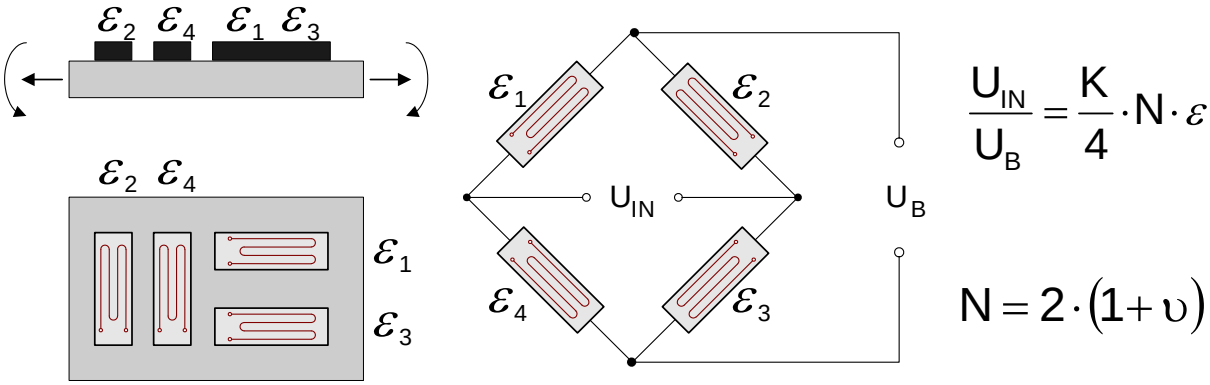


$$\frac{U_{IN}}{U_B} = \frac{K}{4} \cdot N \cdot \varepsilon$$

$$N = 1, 2,$$
$$1-\upsilon, 1+\upsilon,$$
$$2(1-\upsilon),$$
$$2(1+\upsilon)$$

General full bridge. N has to be set from a list.

2.6.2.2.7 Full bridge with Poisson strain gauges in opposed branches



$$\frac{U_{IN}}{U_B} = \frac{K}{4} \cdot N \cdot \varepsilon$$

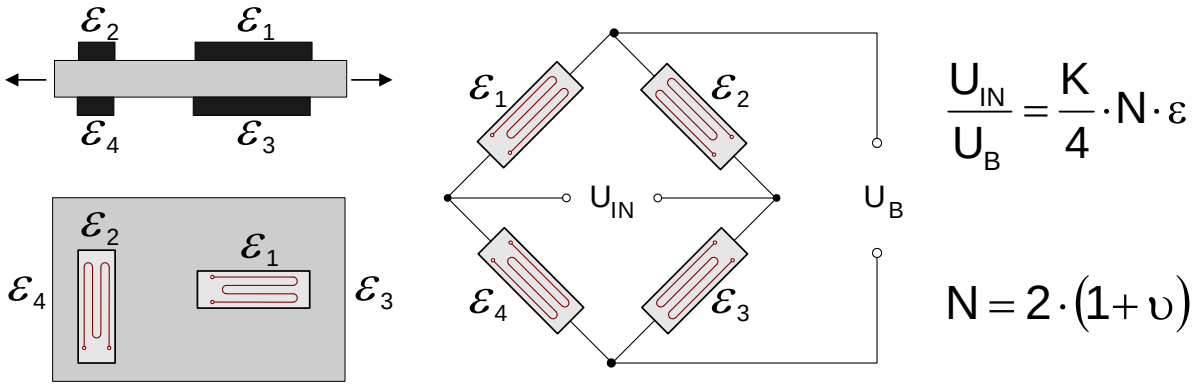
$$N = 2 \cdot (1 + \upsilon)$$

Two active WSGs are positioned along the longitudinal strain and are joined by two transversally positioned WSGs to complete the bridge (torsion bar arrangement). In the bridge, the longitudinal strain gauges are located in opposite branches. This circuit provides better exploitation of transversal contraction and longitudinal force as well as good temperature compensation. In this arrangement, the transversal expansion coefficient must be specified. The strain is computed as:

$$\varepsilon[\frac{\mu}{m}] = \frac{4*1000}{2*k*(1+\nu)} * \frac{Ua}{Ue} \quad [\frac{mV}{V}]$$

k: gauge factor
ν: Poisson's ratio of test object material

2.6.2.2.8 Full bridge with Poisson strain gauges in adjacent branches



$$\frac{U_{IN}}{U_B} = \frac{K}{4} \cdot N \cdot \varepsilon$$

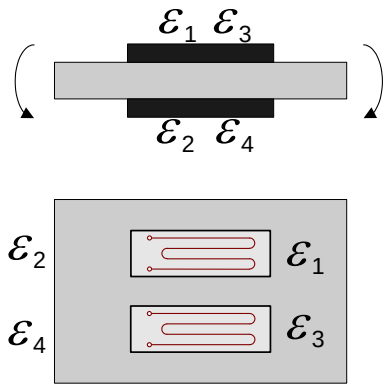
$$N = 2 \cdot (1 + \upsilon)$$

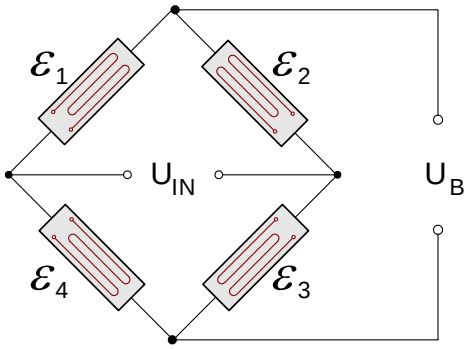
Full bridge with 4 active strain gauges. 2 active strain gauges complemented by 2 transverse Poisson strain gauges. They are located in opposed bridge arms. Higher exploitation of transverse contraction longitudinal expansion while providing good temperature compensation.

$$\varepsilon[\frac{\mu}{m}] = \frac{4*1000}{2*k*(1-\nu)} * \frac{Ua}{Ue} \quad [\frac{mV}{V}]$$

k: gauge factor
ν: Poisson's ratio of test object material

2.6.2.2.9 Full bridge with 4 active strain gauges in uniaxial direction





$$\frac{U_{IN}}{U_B} = \frac{K}{4} \cdot N \cdot \varepsilon$$

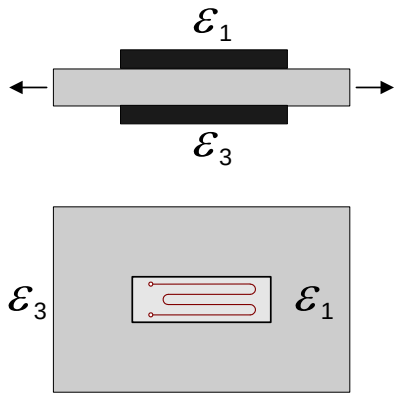
$$N = 4$$

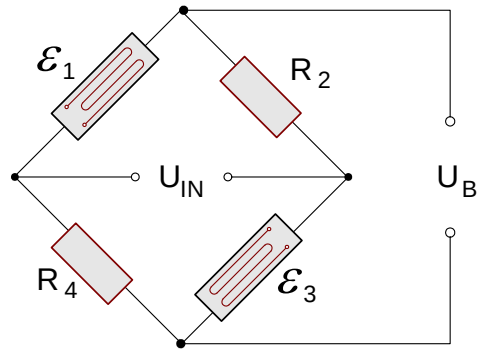
The circuit consists of 4 active WSGs. Two are under compression and the others under equal tension. The strain gauges under tension are positioned in opposite bridge arms. The sensitivity to the moment of bending is increased. At the same time, longitudinal force, torque and temperature are compensated. The strain is computed as:

$$\varepsilon[\frac{\mu m}{m}] = \frac{4 * 1000}{4 * k} * \frac{Ua}{Ue} \; [\frac{mV}{V}]$$

k: gauge factor

2.6.2.2.10 Full bridge (Half bridge-shear strain) with two active strain gauges





$$\frac{U_{IN}}{U_B} = \frac{K}{4} \cdot N \cdot \varepsilon$$

$$N = 2$$

Two active strain gauges are placed under stress in equal magnitude. For measurement of tension and compression (non-linear) to eliminate bending. Temperature gradient should be small. The strain is computed as:

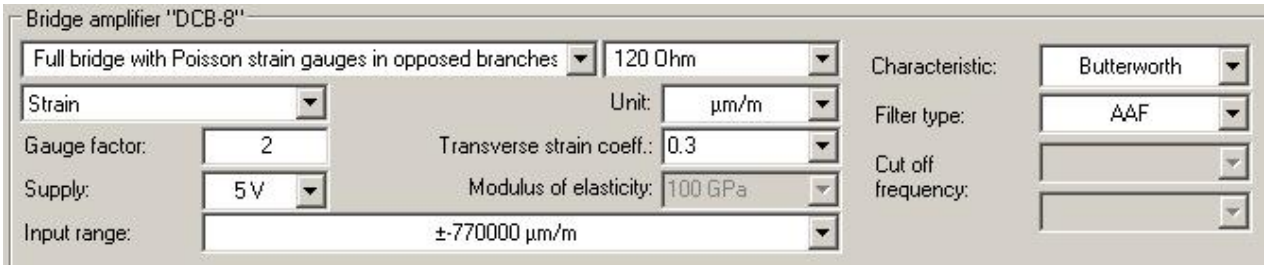
$$\varepsilon[\frac{\mu m}{m}] = \frac{4 * 1000}{2 * k} * \frac{Ua}{Ue} \; [\frac{mV}{V}]$$

k: gauge factor

2.6.2.2.11 Scaling for the strain analysis

It is possible to choose whether to determine the strain or the mechanical stress suffered by the part. In the range of elastic deformation, the axial stress (force / cross section) is proportional to the strain. The proportionality factor is the modulus of elasticity.

Mechanical stress = modulus of elasticity * strain (Hooke's law)



K-factor

The K-factor is the ratio by which the mechanical quantity (elongation) is transformed to the electrical quantity (change in resistance). The typical range is between 1.9 and 4.7. The exact value can be found in the spec sheet for the WSG used. If the value entered for this parameter is outside of this range, a warning message will appear but the module can still be configured.

Transverse strain coeff.

(poisson's ratio): If a body suffers compression or tension and is able to be freely deformed, then not only its length but also its thickness changes. This phenomenon is known as transversal contraction. It can be shown that for each kind of material, the relative change in length is proportional to the relative change in thickness D. The transversal elongation coefficient (Poisson's ratio) is the material-dependent proportionality factor. The material constant is in the range 0.2 to 0.5.

In bridge circuits where the WSGs are positioned transversally to the main direction of strain, this constant must be supplied by the user. The ratios for various materials are available in the list box. These values are only for orientation and may need to be adjusted.

Elastic modulus:

The elastic modulus E, is a material parameter characterizing how a body is deformed under the action of pressure or tension in the direction of the force. The unit for E is N/mm². This value must be entered for the mechanical stress to be determined The e-moduli for various materials are available in the list box. These values are only for orientation and may need to be adjusted.

Unit:

When the strain is determined, the readings appear with the unit µm/m.

For the mechanical stress one can toggle between GPa and N/ mm^2 .

1 GPa = 10^3 N/ mm^2

Note that the elastic modulus is always in GPa.

2.6.3 Incremental encoders

The four incremental encoder channels are for measuring **time** or **frequency**-based signals. In contrast to the analog channels as well as to the digital inputs, the channels are not sampled at a selected, fixed rate, but instead time intervals between slopes (transitions) or number of pulses of the digital signal are measured.

The **counters** used (set individually for each of the 4 channels) achieve time resolutions of up to 31 ns (32 MHz); which is far beyond the abilities of **sampling procedures** (under comparable conditions). The "sampling rate" which the user must set is actually the rate at which the system evaluates the results of the digital counter or the values of the quantities derived from the counters. The description of the Digital In- and Outputs, Inputs for Incremental encoders. 59

2.6.3.1 Signals and conditioning

2.6.3.1.1 Mode

The various modes comprise the following measurement types:

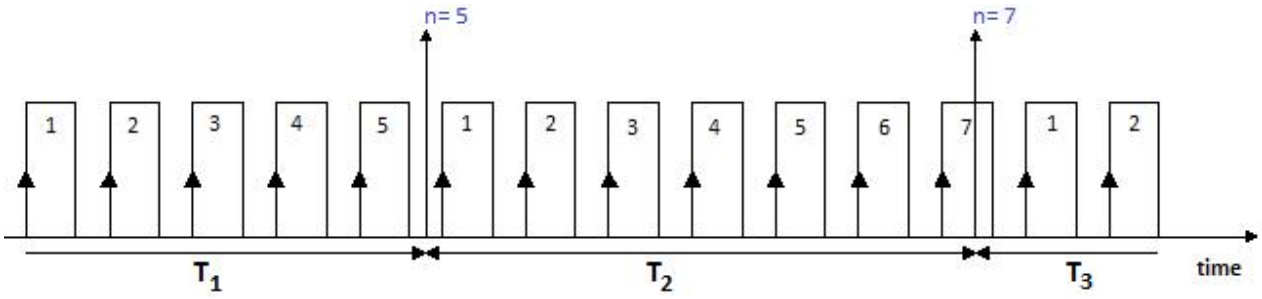
event-counting 41	***time*** 42	***combined measurements*** 43
• events 48 • distance(differential) 48 • angle (differential) 49 • distance (abs.) 48 • angle (abs.) 49	• time 50 • pulse time 51	• frequency 52 • speed 52 • RPM 52

2.6.3.1.2 Event-counting

The following variables are derived from ***Event counting***:

- events 48
- distance(differential) 48
- angle (differential) 49
- distance (abs.) 48
- angle (abs.) 49

The amount of events occurring within one sampling interval is counted. The event counter counts the sensor pulses within the sampling interval. **An event is a positive edge in the measurement signal which exceeds a user-determined threshold value.**

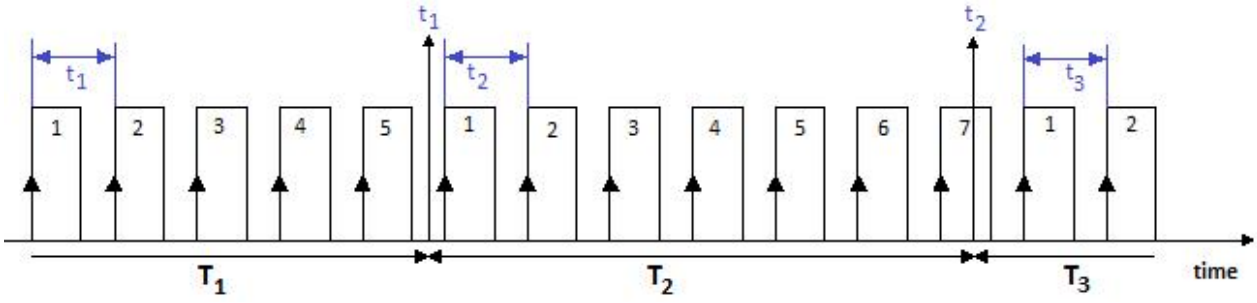


2.6.3.1.3 Time measurements

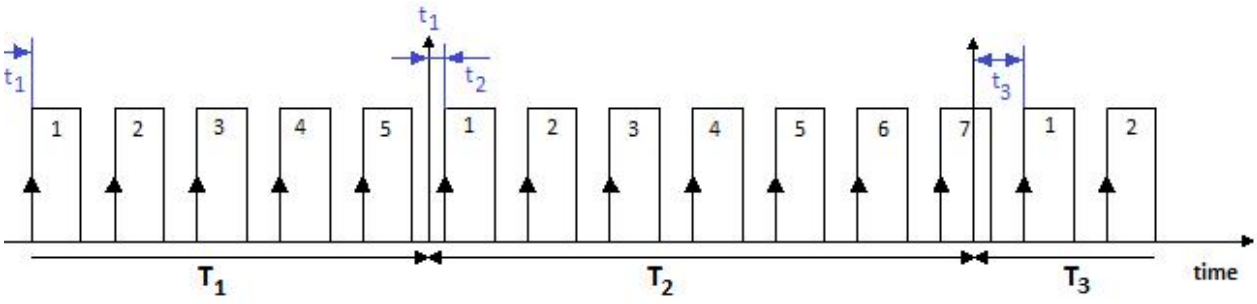
Exclusive measurement of ***time*** is performed as:

- time 50 (of two successive signal edges)
- pulse time 51 (time from the beginning of one sampling interval until the next signal edge)

Any other pulses occurring within the sampling interval are not evaluated for these measurement types.



time

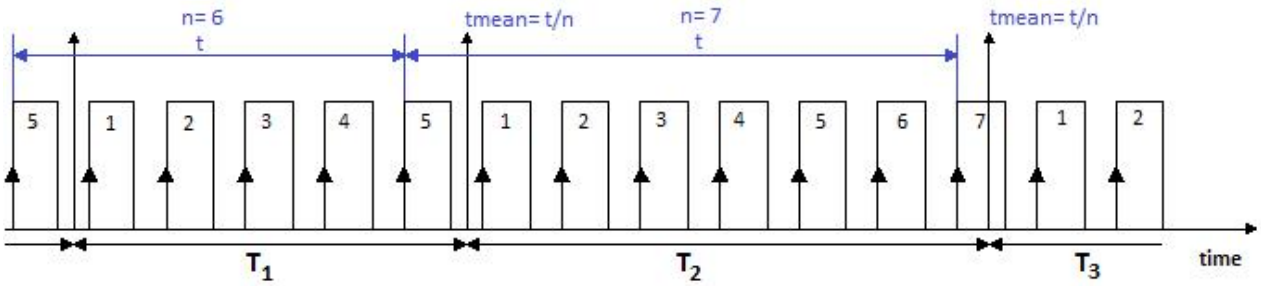


pulse time

2.6.3.1.4 Combination mode

Determining a frequency and the derivative quantities RPM and velocity is based on the **combination of event counting and time measurement**. In other words, during a sampling interval, the number of events occurring as well as the time interval between the first and last event are measured:

- frequency 52
- speed 52
- RPM 52



The frequency is determined as the number of events counted divided by the time between the first and the last "complete" event in the interval. An event is complete when a positive edge is succeeded by a subsequent positive edge.

The frequencies must lie within the range 30m Hz < f < 450 kHz. If the maximum frequency is exceeded during a measurement, the system returns the input range end value instead of the true measured values.

The derivative quantities displacement and angle measurement have the following settings:

- Choice of one-signal and two-signal encoder 47
- Start of measurement with or without "Zero impulse" 47
- Number of pulses (per unit)

The frequency resolution of the measurement results depends on the input range selected.

Input ranges and the corresponding frequency resolutions			
Input range	**Frequency resolution**	**Input range**	**Frequency resolution**
450 kHz	15.2588 Hz	3 kHz	119.2m Hz
200 kHz	7.6294 Hz	1.5 kHz	59.6m Hz
100 kHz	3.8417 Hz	750 Hz	29.8m Hz
50 kHz	1.907 Hz	450 Hz	14.9m Hz
25 kHz	0.9537 Hz	200 Hz	7.45m Hz
12,5 kHz	0.4768 Hz	100 Hz	3.73m Hz
7 kHz	0.2384 Hz	50 Hz	1.86m Hz

The input ranges and resolutions for the RPM or velocity also depend on the number of encoder pulses set. If the number of pulses is known, the RPM and velocity values can easily be computed using the above table according to:

RPM:
Input range = ([Frequency input range in Hz] * 60 / [Encoder pulses per revolution]) in RPM
Resolution = ([Frequency resolution in Hz] * 60 / [Encoder pulses per revolution]) in RPM

Behavior in response to missing signal pulses

If a sequence of signal pulses is slowing down and then one sampling interval elapses without any pulse, no calculation can be performed for that sampling interval. In that case, the system assumes that the rotation speed is simply decreasing and an attenuating signal course is extrapolated. This "estimated" measurement value is then closer to the true value than the value determined from the preceding sampling interval. This technique has demonstrated its validity in practice.

Note

In extreme cases, the sensor does not return any more pulses, e.g. in case of a sudden outage. Then the algorithm generates an attenuation curve, meaning values > 0, even if the measurement object is actually no longer moving.

2.6.3.1.5 Differential measurement procedures

The quantities derived from *event-counting*, **Events, Distance** and **Angle** denoted by the annotation **(diff.)** are "differential" measurements. The quantity measured is the respective change of displacement or angle within the last sampling interval. (positive or, for dual track encoders, negative also) or the newly occurred events (always positive).

If, for instance, the total displacement is desired, it must be calculated by **integration** of the differential measurements using Online FAMOS functions.

2.6.3.1.6 Cumulative measurements

The quantities derived from *event-counting*, **Distance** and **Angle** appearing with the annotation **(abs.)** are "**cumulative**" measurements.

In "**cumulative**" measurement, the return value is the **sum** of all displacement or angle changes, or of all event which occurred.

2.6.3.1.7 Scaling

A **maximum** value must be entered under ***Input range*** (max. frequency etc, depend on mode). This **Maximum** determines the scaling factor of the computational processing and amounts to the range which is represented by the available numerical format of 16bits. Depending on the measurement mode (quantity to be measured), it is to be declared as an input range's unit or in terms of a corresponding max. pulse rate.

In the interest of maximizing the **measurement resolution** it is recommended to set this value accordingly.

The ***Scaling*** is a sensor specification which states the relation between the pulse rate of the sensor and it's corresponding physical units (sensitivity). This is also the place to enter a conversion factor for the sensor along with any physical quantity desired, for instance, to translate the revolutions of a flow gauge to a corresponding volume.

The table below summarizes the various ***measurement types' units***;
the bold, cursive letters denote the (fixed) primary quantity, followed by its (editable) default physical unit:

Measurement quantity	(Sensor-) scaling	Range	Maximum
Linear motion	Pulse / m	m	m / s
Angle	Pulse / U	U	U / min
Velocity	Pulse / m	m / s	m / s

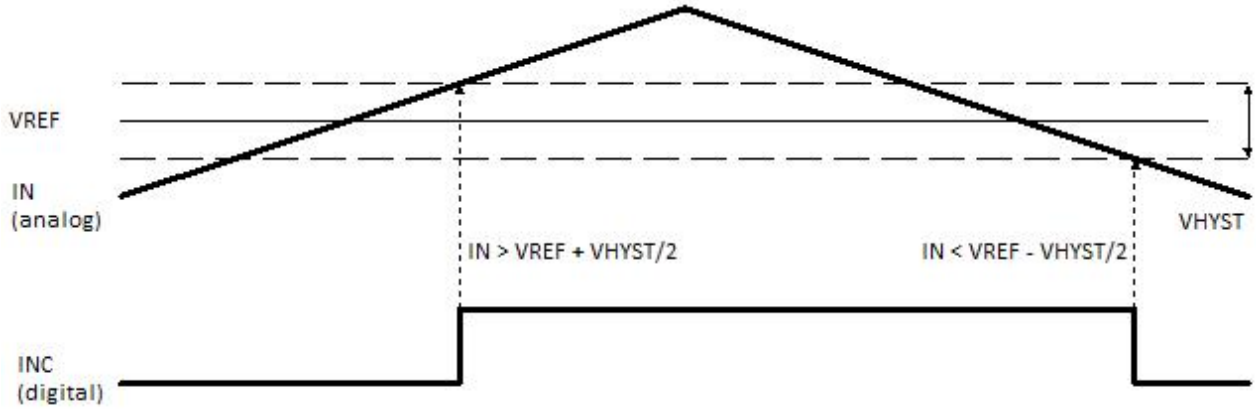
Measurement quantity	(Sensor-) scaling	Range	Maximum
RPM	Pulse / U	U / min	U / min
Event	Pulse / Pulse	1 Pulse	Hz
Frequency	Hz / Hz	Hz	Hz
Time	s / s	s	s
Pulse time	Hz/Code	Hz	Hz

2.6.3.1.8 Comparator conditioning

The incremental encoders' special properties make **special demands for signal quality**: the very high resolution offered by the detector or counter means that even very short impulses can be captured and evaluated, which sampling-based measurement methods (such as for the digital inputs of the DI16 module) would not (or almost never) be able to detect. Therefore, the digital signals must have clear edges in order not to produce disturbed readings. Spurious impulses or contact bouncing can lead to artifacts such as enormous peaks in RPM-signals etc..

Simple sensors working on the principles of induction or photoelectric relays often emit unconditioned analog signals which must be evaluated according to a threshold condition. Aside from that, problems can occur even with conditioned encoder signals (e.g. TTL-levels) due to long cables, bad reference voltages, ground loops or interference. imc incremental encoder channels are able to counteract these problems thanks to a special 3-stage conditioning unit:

First comes a high-impedance **differential amplifier** (± 10 V range, 100kOhm) which enables reliable acquisition from a sensor even over a long cable as well as effective suppression of common mode interference and ground loops. Next, a (configurable) **smoothing filter** offers additional interference suppression adapted to the measurement situation. Lastly, a **comparator** with adjustable threshold and hysteresis serves as a digital detector. The (adjustable) **hysteresis** also serves to suppress interference:



If the analog signal exceeds the threshold **VREF + VHYST/2**, the digital signal changes its state (: 0 -> 1) and simultaneously reduces the threshold which the signal must fall below in order for the state to return to 0 by the amount VHYST. Thus, the threshold for the next state transition from 1 to 0 is **VREF – VHYST/2**. The size of the hysteresis represents the width of a range-band inside of which the signal can fluctuate (due to signal noise and interference) without an impulse being recorded.

Ranges:

- VREF (Threshold) = -10 V .. +10V
- VHYST (Hysteresis) = +100 mV...+4V
- Low pass filter: None, 20 kHz, 2 kHz, 200 Hz

2.6.3.1.9 Single-signal/ Two-signal

The **single signal counter** returns a simple pulse sequence. This means that the pulse count and the time between pulses can be determined, but not the rotation direction of the incremental counter.

A **two signal encoder** returns two pulse sequences with a 90° offset. Along with the pulse frequency, the rotation direction can also be indicated as positive or negative. A measurement with two-signal counters is selected in the combobox “Measurement mode” together with the desired operation type.

2.6.3.1.10 Zero pulse (index)

The **zero pulse** starts the encoder channels' counter mechanism. This means the measured values are only recorded if an event occurs at the **index-channel**. If measurement without a zero pulse is selected, the measurement starts directly upon preparing the measurement.

Note

- **The system only takes the zero pulse into account following preparing the measurement. Restarting the measurement does not cause a reset.**
- If the zero pulse fails to appear, the INC4 does not start measurement at all. In that case, the channels only return zero.
- The index channel only applies to all four channels of the module.

2.6.3.2 Mode (events-counting)

2.6.3.2.1 Events

The event counter counts the sensor pulses which occur during a single time interval (differential event counting). The interval corresponds to the sampling time set by the user. The maximum event frequency is about 500 kHz.

An event is a positive edge in the measurement signal which exceeds the user-set threshold value.

The derivative quantities displacement and angle measurement have the following settings:

- Choice of one-signal and two-signal encoder 47
- Start of measurement with or without “Zero impulse” 47
- Number of pulses (per unit)

2.6.3.2.2 Distance

Distance (differential)

Path traveled within one sampling interval. For this purpose, the number of pulses per meter must be entered.

Distance (absolute)

Absolute distance. The differential distance measurement is converted to the absolute distance. By taking the zero impulse (the counter with no zero impulse should not be selected) into account, the absolute distance position is determined and indicated. Otherwise, the distance value is assumed to be 0° when the measurement begins.

2.6.3.2.3 Angle

Angle (differential)

Angle traveled within one sampling interval. For this purpose, the number of pulses per revolution must be entered. The absolute angle can be calculated in imc Online FAMOS or determined by the mode Angle(abs).

Angle (absolute)

Absolute angle. The differential angle measurement is converted to the absolute angle. By taking the zero impulse (the counter with no zero impulse should not be selected) into account, the absolute angle position is determined and indicated. Otherwise, the angle value is assumed to be 0° when the measurement begins.

2.6.3.3 Mode (Time measurement)

2.6.3.3.1 Time measurement

The time measurement mode allows the definition of **edge conditions** between which the time interval is to be measured.

The following combinations are possible:

positive edge ⇒ negative edge: (↑ ⇒ ↓)

negative edge ⇒ positive edge: (↓ ⇒ ↑)

positive edge ⇒ positive edge: (↑ ⇒ ↑)

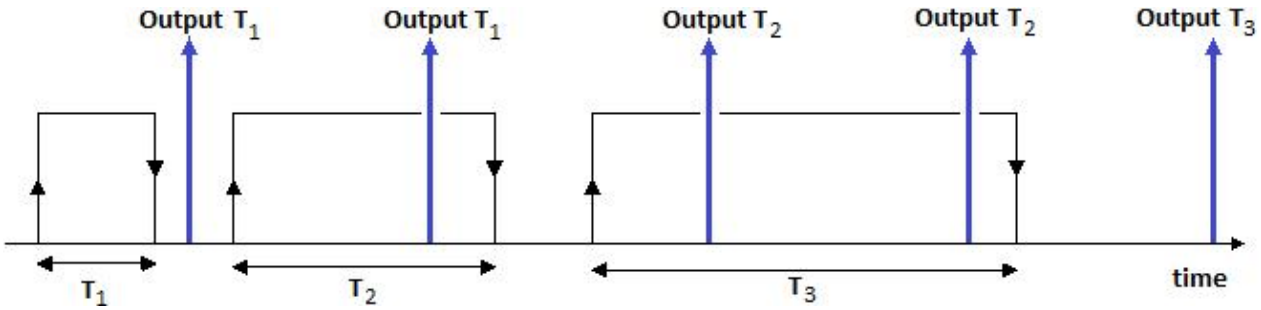
The combination negative edge ⇒ negative edge: (↓ ⇒ ↓) is not allowed

To ensure a high time resolution for the measurement results, suitable scaling must be set for the measurement. An **input range** specifies the maximum time interval which can be measured between the selected starting and stopping edge. T**he time between the signal edges may not be greater than the selected input range.** If the maximum time interval is exceeded during measurement, the system returns the input value range end instead of the true measured value.

Input range	Time resolution	Input range	Time resolution
1 ms	31,25ns	250 ms	8us
2 ms	62,50ns	500 ms	16us
4 ms	125,00ns	1s	32us
8 ms	250,00ns	2s	64us
16 ms	500,00ns	4s	128us
30 ms	1us	8s	256us
60 ms	2us	16s	512us
120 ms	4us	30s	1024 ms

The time resolution corresponds to the value of an LSB (Least Significant Bit).

During sampling intervals when no time measurement was possible (because either a starting or stopping edge was missing), the last valid return value continues to be returned until a time measurement is completed. If there is no valid return value, zero is returned. If more than one time measurement is completed during a single sampling interval (due to multiple starting and stopping edges), the last time measured is returned.



Above is illustrated a measured signal from which time readings are taken. Each reading starts at a positive edge in the signal and is stopped at a negative edge. The "up" arrows indicate the times at which the system returns a result. The returned values in this case are T1 –twice; T2 –twice; and T3.

2.6.3.3.2 Pulse Time

The point in time at which the edge is located within the sampling interval is determined. This information is needed by some functions in imc Online FAMOS, e.g. for determining the course of the RPMs from a pulse signal: OtrEncoderPulsesToRpm.

The measurement variable ***Pulse Time*** refers to phase-based data which is only relevant to special applications (particularly order-tracking analysis). It is required for subsequent online calculations. It represents the time between the last detected (asynchronous) pulse and the (synchronous) sampling time at which the counter readings were sampled and evaluated. The unit associated with this variable is called *Code*.

Note

The mode *Pulse Time* depends on the sampling rate. For all ENC-4 types, the entry is visible only if the sampling rate is equal or smaller 1ms. For HRENC-4 the sampling rate must be equal or less 100µs.

2.6.3.3.3 PWM

Measurement of PWM can not be performed directly with C-SERIES.

However, if the frequency is known, it is possible to perform it indirectly by time measurement with the following settings:

The **ratio** is the *Duration of HIGH (signal) level* over the *Period duration*.

The *Duration of HIGH (signal) level* is obtained by means of a **time measurement** from *positive to negative (signal) edge*.

Die *Period duration* is the **inverse of the frequency**, which must be known.

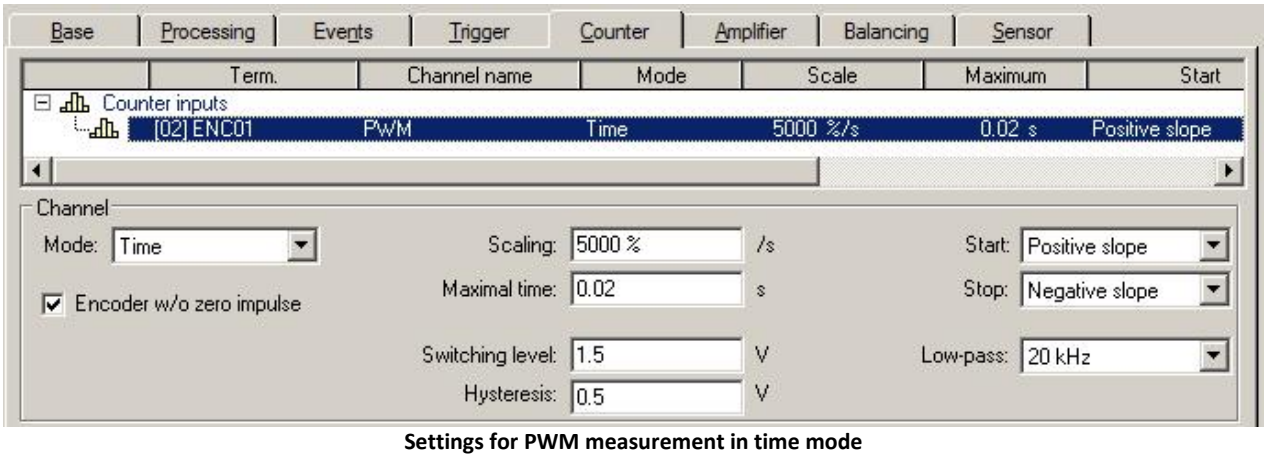
PWM= $t_{pulse}/t_{Period\ duration}$ * 100% or t_{pulse} * f * 100%

Example: f= 50Hz, Pulse duration = 10ms

Scaling: t_{pulse} * f * 100%/ s = 5000%/s

at 10ms: 0.01s*5000%/s= 50%

This can be entered directly via the scaling:



Settings for PWM measurement in time mode

2.6.3.4 Mode (combined measurement)

2.6.3.4.1 Frequency

Frequency is determined by means of a combination measurement 43. If the frequency was previously multiplied or divided, this can be reflected in the scaling value. The frequency is always unsigned, for which reason there is no two-signal encoder for it.

2.6.3.4.2 Speed

The sequence of pulses is converted to m/s by means of a combination measurement 43. Toward this end, the number of pulses per meter must be entered.

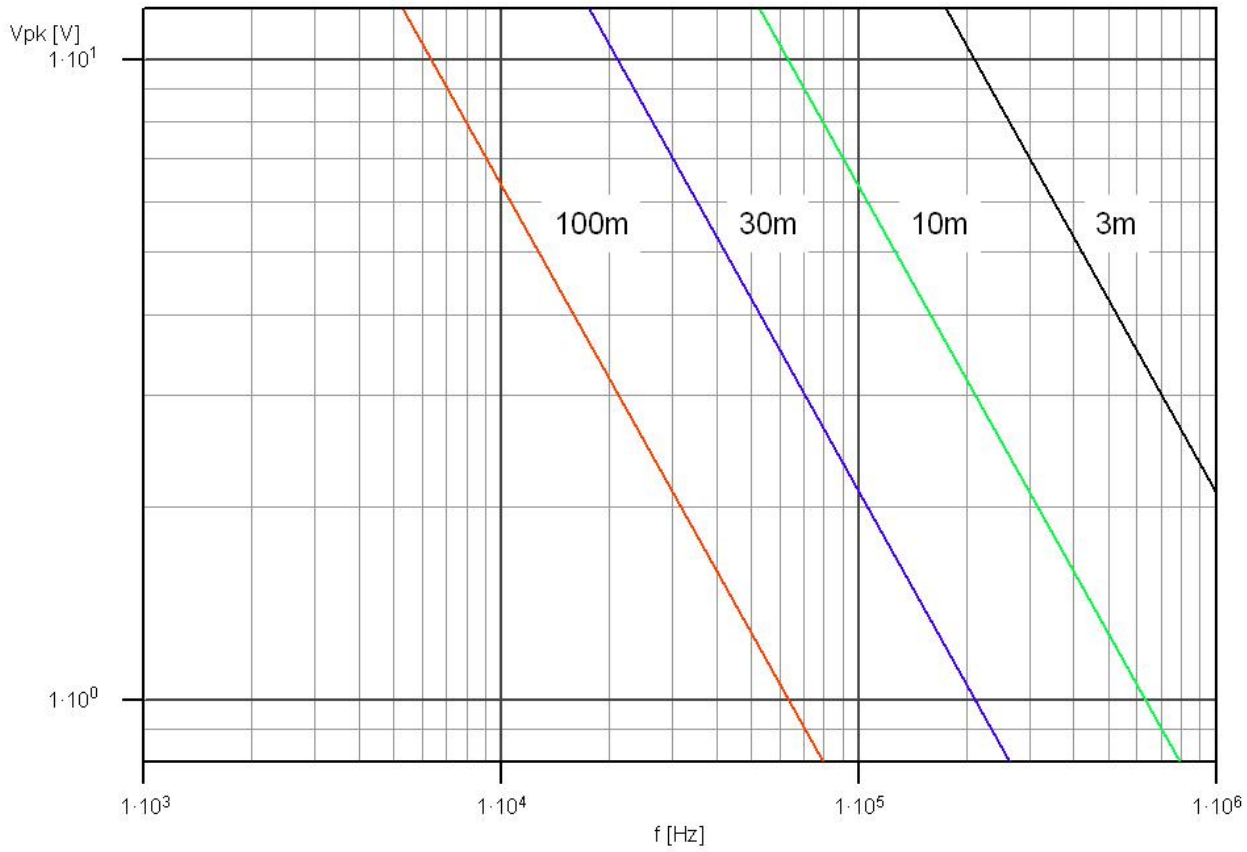
2.6.3.4.3 RPM

The sequence of pulses is converted to revolutions per minute by means of a combination measurement 43. Toward this end, the number of pulses per revolution must be entered.

2.6.4 Measurement with current-fed sensors

With current-fed sensors (e.g. ICP™-, DELTATRON®-, PIEZOTRON®-, PIEZOBEAM®-sensors), the capacitive burden on the signal due to the cable capacitance can lead to clipped amplitudes for higher frequencies. To avoid signal distortion, try to:

1. keep the cable short,
2. use a low-capacitance cable,
3. use a less sensitive sensor.



Maximum signal amplitudes as a function of the signal frequency and the cable length, with a 4 mA feed and a capacitance of 100 pF/m.

2.6.4.1 Supply current

The exact ***magnitude of the supply current*** is irrelevant for the measurement's precision. Values of 2 mA tend to be adequate. Only in the case of very high bandwidth and amplitude signals in conjunction with very long cables, supply currents may be a concern, as considerable currents are need to dynamically charge the capacitive load of the cable.

dynam. current headroom:	I	= 4 mA
cable capacity (typ. coax-cable):	C	= I * 100 pF/m
max. signal slew rate (full-power):	dU/dt	= 5 V * 2 * PI * 25 kHz
→ max. cable length:	L_{max}	= 4 mA / (100 pF/m * 5 V * 2 * PI * 25 kHz) = 50 m

Up to a **max. cable length of 50 m**, no limitations are to be expected as long as the above conditions are fulfilled.

Find here the description of the ICP-connector. 68

Technical Details: ACC/DSUB-ICP. 177

2.6.5 Overdriving a measurement range

Generally, all conditioning modules allow linear operation up to minimum 100% of the selected nominal full scale range. The numerical implementation of imc CRONOS data structures however, theoretically allows the representation of twicre the nominal range (±2xFS).

The analog signal path usually allows for some additional overdriving margin, even without leaving the linear transmission range. Overdriving behaviour is also determined by analog and numerical limits of the ADC and numerical limits of subsequent signal processing. Additionally, certain internal reserves in signal range are necessary to account for characteristic filter settling and overshoot, as well as calibration headrooms. All these aspects lead to slightly varying limits and behaviour with respect to hard or soft saturation or increasing nonlinearities. These can depend on actual module type, chosen mesurement mode and range.

To facilitate easy identification of overrange status, the C-series device CS-6004, CL-6012 implement the following behaviour:

If some internal signal exceeds its allowable range, which will typically be the case at aprox 105% of full scale range (±1.05 x FS), then the output and displayed data value will be forced to exactly (±2 x FS). This serves an an explicit indicator for an invalid operating condition. It is intended as a “warning flag” to prompt the user for selecting an appropiate measurement range. As such it is considered an extra feature and benefit, that will assist in avoiding any invalid measurement data, as in an overdriving case, a relieable relation between displayed data and real world signals can no longer be guaranteed.

Additionally the overrange “flagging” will incorporate a “monoflop” behaviour: any detected illegal overrange state will be extended and flagged to a minimum duration of 200 µs.

In this context, it is important to be aware, that any detected internal overdriving might refer to an unfiltered raw input signal, not yet subjected to digital filtering or other signal processing. This is why it is well possible, that a low pass (or AAF) filtered channel might still appears to be within the nominal range, while the raw input and thus internal nodes, containing significant high frequency content, could already exceed the allowable range. Such a case would be characterized by a displayed signal that would instantly jump from maybe 80% FS to 200% FS.

These type of overrange limitations are in fact a natural and inevitable charactersitic of any data acquisition and measurement system – either analog or digital. Especially when dealing with wide band signals, and low pass signal conditioning, it has to be guaranteed that analog and digital linear signal ranges are covered with sufficient headroom in all relevant stages of the signal chain.

In practical applications, this means that the measurement range has to be chosen by taking in account sufficient headroom margin, to cover the maximum levels under all expected conditions. If in doubt, an unfiltered measurement, temporarily deselecting any low pass or anti-aliasing filter, might unveil unexpected peak levels and verify a correct setting.

Device description

CS-1016

CS-8008

CL-7016

3.1 Hardware configuration of all devices

All devices belonging to the imc C-SERIES are equipped with:

- 4 incremental counter inputs
- 4 analog outputs
- 8 digital inputs
- 8 digital outputs

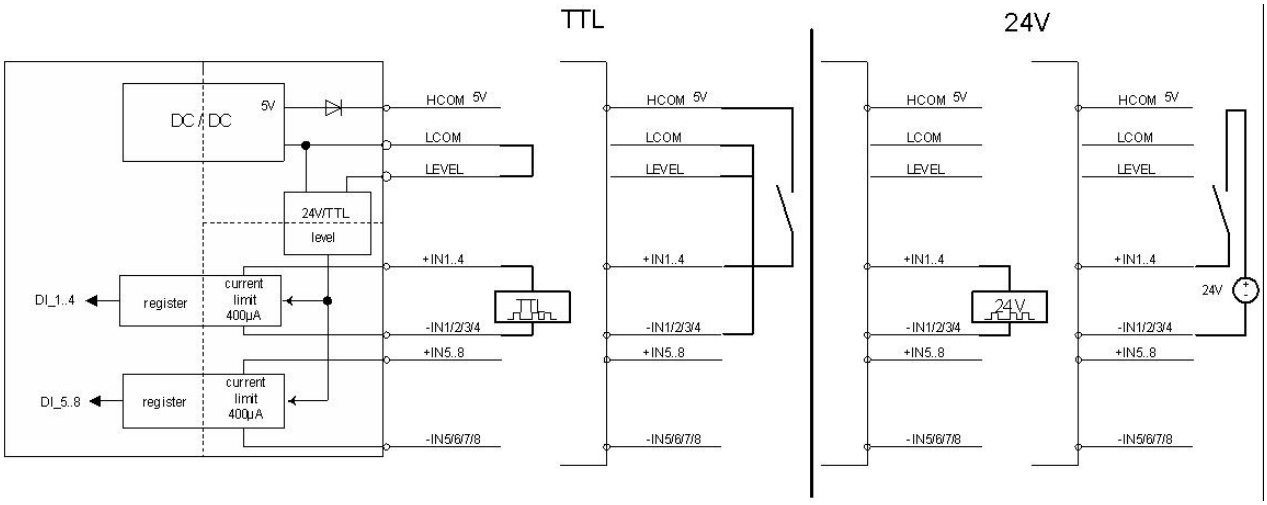
3.1.1 Digital In- and Outputs, Inputs for Incremental encoders

There are 8 binary inputs, 8 binary outputs and 4 incremental encoder inputs.

3.1.1.1 Digital Inputs

The DI potion possesses 8 digital inputs which can take samples at rates of up to 10 kHz. Every group of four inputs has a common ground reference and are not mutually isolated. However, this input group is isolated from the second input group, the power supply and CAN-Bus, but not mutually.

The technical specification of the digital inputs 170.
The pin configuration of the ACC/DSUB(M)-DI4-8 189.



Open inputs are set to have LOW voltage by means of pull-down resistors

3.1.1.1.1 Input voltage

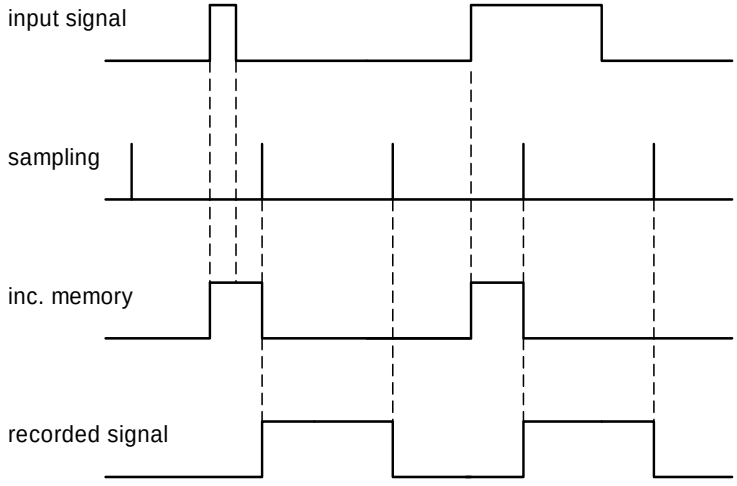
The input voltage range for a group of eight digital inputs can be set for either 5 V (TTL-range) or 24 V. The switching is accomplished by means of a jumper at the ACC/DSUB-DI4-8 connector:

- If LEVEL and LCOM are jumpered, all 8 bits work with 5 V and a threshold of 1.7 V to 1.8 V.
- If LEVEL is not bridged with LCOM, 24 V and a threshold of 6.95 V to 7.05 V are valid.

Thus, an unconnected connector is set by default for 24 V. This prevents 24 V from being applied to the voltage input range of 5 V.

3.1.1.1.2 Sampling interval and brief signal levels

The digital inputs can be recorded in the manner of an analog channel. It isn't possible to select individual bits for acquisition; all 16 bits (digital port) are always recorded. The hardware ensures that the brief HIGH level within one sampling interval can be recognized.



3.1.1.2 Digital outputs

The digital outputs DO_01..08 provide galvanically isolated control signals with current driving capability whose values (states) are derived from operations performed on measurement channels using imc Online FAMOS. This makes it easily possible to define control functions.

The technical specification of the digital outputs 171.
The pin configuration of the ACC/DSUB(M)-DO8 189.

Important notes

- available levels: 5 V (internal) or up to 30 V with external power supply
- current driving capability:
  HIGH: 15 mA to 22 mA LOW: 700 mA
- short-circuit-proof to supply or to reference potential HCOM and LCOM
- configurable as open-drain driver (e.g. as relay driver)
- default-state at system power-on:
  HIGH (Totem-Pole mode) or high-impedance (Open-Drain mode)
- The eight outputs are galvanically isolated as a group from the rest of the system and are designed as Totem-Pole drivers. The eight stages' ground references are connected and are accessible as a signal at LCOM.

HCOM represents the supply voltage of the driver stage. It is generated internally with a galvanically isolated 5 V-source (max. 1 W). Alternatively, an external higher supply voltage can be connected (max. +30 V), which then determines the drivers' output level.

The control signal OPDRN on the DSUB plug can be used to set the driver type for the corresponding 8-bit-group: either Totem-Pole or Open-Drain :

In Totem-Pole mode, the driver delivers current in the HIGH-state. In the Open-Drain configuration, conversely, it has high impedance in the HIGH-state, in LOW-state, an internally (HCOM) or externally supplied load (e.g. relay) is pulled down to LCOM (Low-Side Switch).With Open-Drain mode, the external supply driving the load, need not be connected to HCOM but only to the load.

Inductive loads (relays, motors) should be equipped with a clamp diode in parallel for shorting out switch-off transients (anode to output, cathode to positive supply voltage).

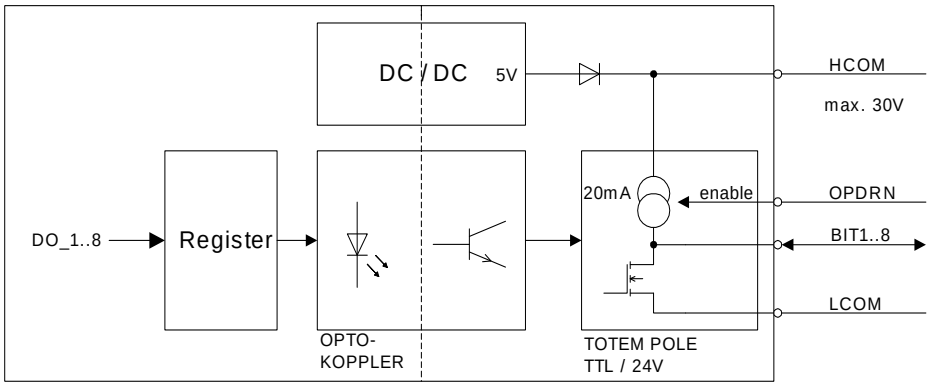
Power-up response:

0)	deactivated	high-Z (high resistance)
1)	power-up	high-Z (high resistance) High- and LowSide switch inactive
2)	first write access	With “Prepare measurement” following Reset or Power-up (setting procedure): activation of the output state with the mode set by the programming pin “OPDRN”

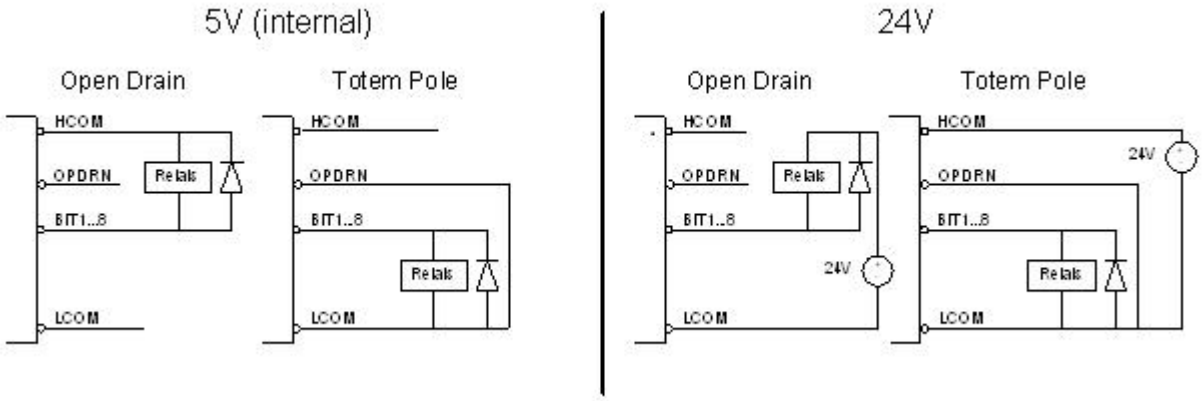
Example:

wire jumper between programming pin “OPDRN” and LCOM (-> Totem-Pole driver type)
Initialization (first setting procedure) with 0 (LOW)
→ resulting startup sequence: High-Z → LOW, without intermediate HIGH state!
Without further steps the default initialization state while preparing measurement is: “LOW”.
If a different state is desired, the appropriate checkmark must be set in the DIO interface dialog, namely under:
Settings → Input/ Output channels → Set values of Input/ Output channels in the experiment
and not at: Measure → Input/ Output channels → Read and write Input/ Output channels!

3.1.1.2.1 Block schematic



3.1.1.2.2 Possible configurations



With Totem Pole, a maximum of 22 mA load current is possible, totally independently of any externally connected voltage.

Open Drain is able to switch currents of up to 700 mA. When using the internal 5 V power supply, note that the limit on total current at all outputs is 200 mA.

3.1.1.3 Incremental encoder channels

You can find a general description in incremental-encoder description 41.

The technical specification of the incremental encoder 172.

The pin configuration of the ACC/DSUB(M)-ENC-4 189.This enables all four incremental encoders to a single connector.

3.1.1.3.1 Sensor types, synchronization

Index signal denotes the synchronization signal SYNC which is globally available to all four channels in common. If its function Encoder w/o zero impulse is not activated, the following conditions apply: After the start of a measurement the counters remain inactive until the first positive slope arrives from SYNC. This arrangement is independent of the release-status of the Start-trigger condition.

The index signal is armed for each measurement!

If a **sensor without an index track** (Reset signal) is used, ***Encoder w/o zero impulse*** **must be selected**, otherwise the counters will remain in reset-state and will never be started because the enabling start-impulse will never occur!!

Incremental encoder sensors often have an index track (index signal, zero marker pulse) which emits a synchronization-signal once per revolution. The SYNC-input is differential and set by the comparator settings. Its bandwidth is limited to 20 kHz by a permanently low-pass filter. If the input remains open, an (inactive) HIGH-state will set in.

The measurement types Linear Motion, Angle, RPM and Velocity are especially well adapted for direct connection to incremental encoder-sensors. These consist of a rotating disk with fine gradation in conjunction with optical scanning and possibly also with electric signal conditioning.

One differentiates between single track and dual track encoders. Dual track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B (C and D). By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported.

The actual time or frequency information, however, is derived exclusively from the A(C) -track!

The measurement types Event, Frequency, and Time always are measured by one-track encoders, since in these cases no evaluation of direction or sign would make any sense. The sensor must simply be connected to the terminal for Track A (C).

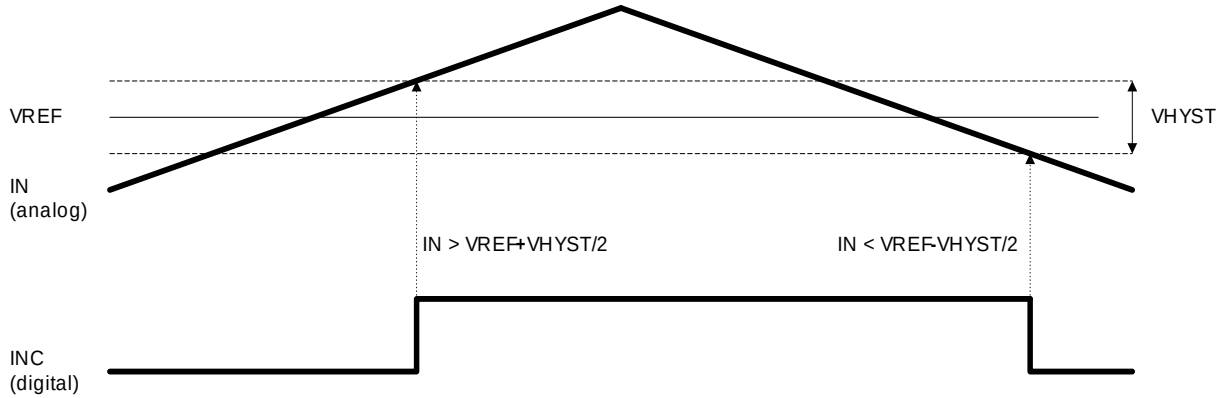
Since many signal encoders require a supply voltage, +5 V are provided at the connector socket for this purpose (max. 300 mA). The reference potential for this voltage, in other words the supply-ground connection for the sensor, is CHASSIS.

3.1.1.3.2 Comparator conditioning

The incremental encoder channels' special properties make special demands on the signal quality: The very high time-resolution of the detector or counter means that even extremely short impulses which sampling measurement procedures (as at the digital inputs) would miss are captured and evaluated. Therefore the digital signals must have clean edges in order not to result in distorted measurements. Missed pulses or bounces could otherwise lead to drop-outs in the time measurements, or enormous "peaks" in the rpm-measurements.

Simple sensors such as those based on induction or photosensitive relays often emit only unconditioned analog signals which must be evaluated in terms of a threshold value condition. Furthermore long cables, ground loops or interference, can make the processing of even conditioned encoder signals (such as TTL-levels) difficult. The device, however, can counteract this using its special three-step conditioning unit.

To begin with, a high-impedance differential amplifier (±10 V range, 100 kΩ) enables reliable measurement from a sensor even along a long cable, as well as effective suppression of common mode interference and ground loops. A (configurable) filter (in preparation) at the next stage offers additional suppression of interference, adapted to the measurement set-up. Finally, a comparator with configurable threshold and hysteresis acts as a digital detector. The (configurable) hysteresis is an extra tool for suppressing noise:



If the analog signal exceeds the threshold VREF + VHYST/2. the digital signal changes its state (: 0 ⇨ 1) and at the same time reduces the threshold which must be crossed in order to change the state back to 0 by the amount VHYST (new threshold: VREF - VHYST/2). The magnitude of the hysteresis therefore represents the maximum level of noise and interference that would not cause a spurious transition.

The threshold VREF is set to 1,5 V, the hysteresis VHYST is 0,5 V.
State transitions are therefore detected at the signal amplitudes:

1.75 V ***(0 ⇨ 1)*** and ***1.25 V*** ***(↓ 1 ⇨ 0)***.

In future device versions, the threshold and hysteresis will be globally adjustable for all four channels within the range:

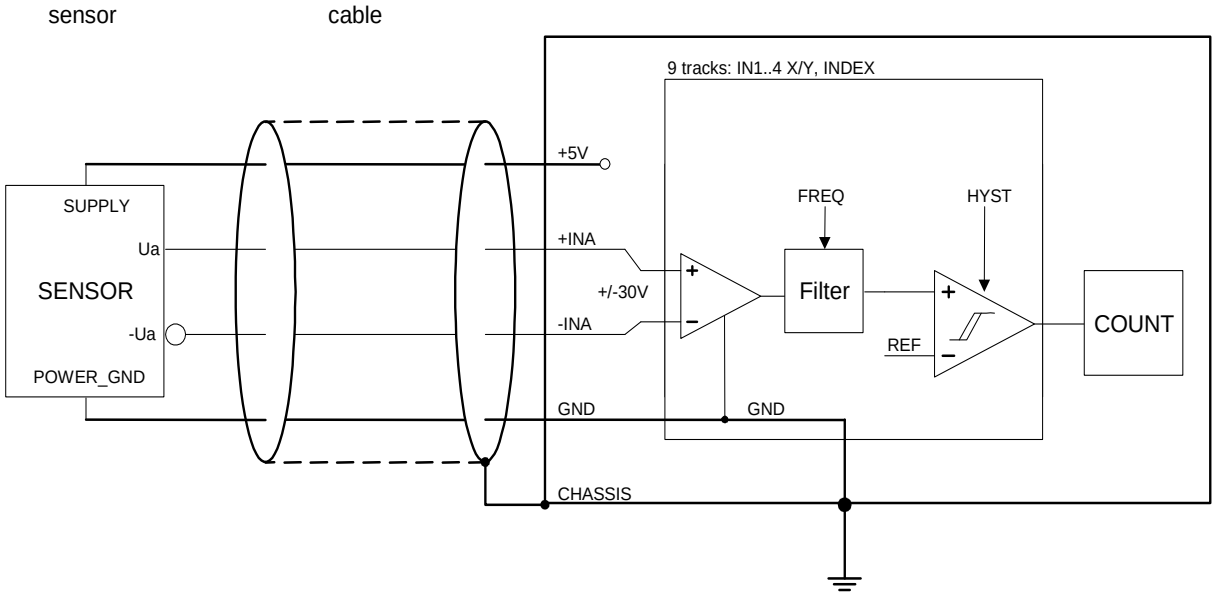
- VREF = ±10 V VHYST = +100 mV .. +4 V

Corner frequencies of the (2-pole) low-pass filter will be jointly configurable for both of a channel's tracks to the values: Low-pass filter: 20 kHz, 2 kHz, 200 Hz

3.1.1.3.3 Structure

Complete conditioning with individual differential inputs is provided for 4 tracks: they can be used for four channels with one-signal-encoders or for two channels with two-signal encoders.

Block schematic



Dual track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B. By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported. The actual time or frequency information, however, is derived exclusively from the A-track!

Like the other channels, the Index-channel is fully conditioned. If its function is activated, it can take effect on all four channels.

3.1.1.3.4 Channel assignment

The connector used is the ACC/DSUB(M)-ENC-4. This connector enable all four incremental counters to be connected at the same terminal.

As a prerequisite for the input differential amplifier to find the correct working point, the sensor must be ground referenced, i.e. it must have low resistance to ground (GND, CHASSIS, PE). This is not to be confused with the sensor's common mode voltage, which may be up to +25 V/-12 V (even for the –IN input!). It also does not matter that a differential measurement is configured for the high-impedance differential input. If this electrical connection to the system ground (CHASSIS) does not exist initially because the sensor is electrically isolated, then such a connection must be set up, for instance in the form of a wire jumper between the sensor's GND and POWER_GND contacts!

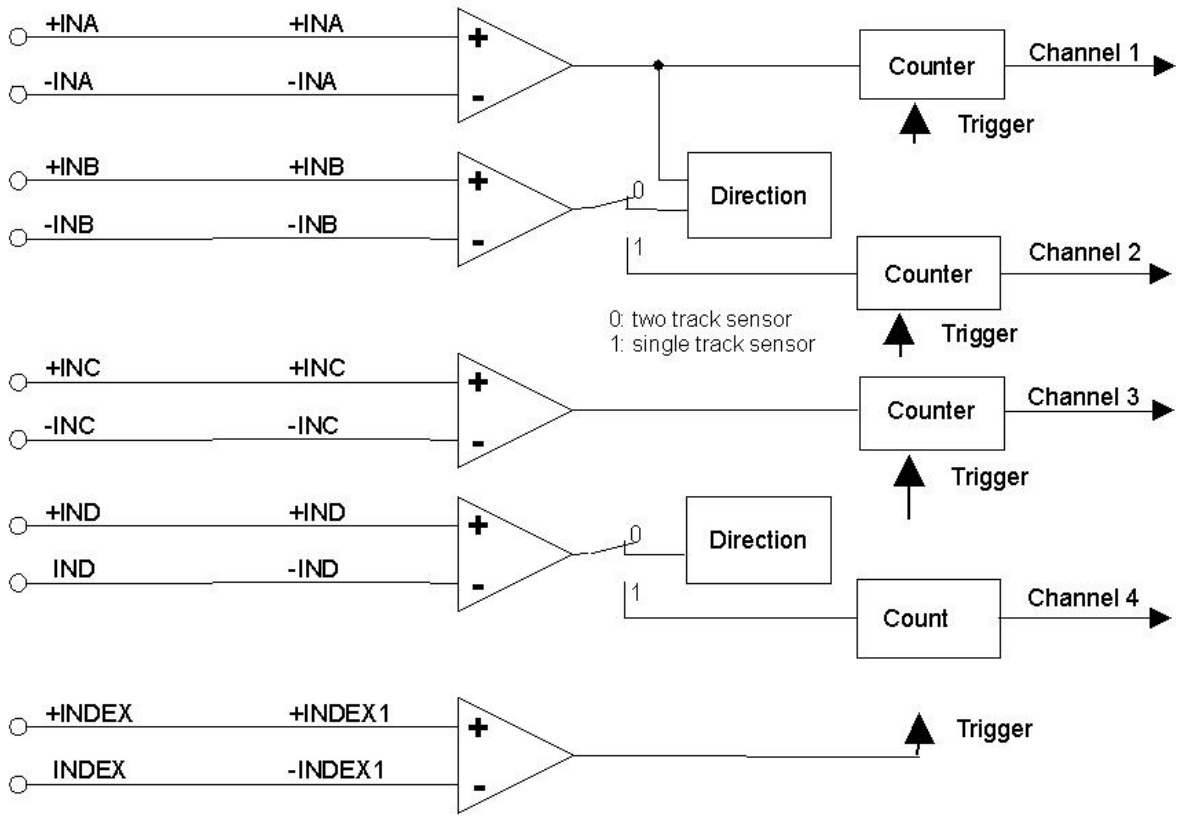
The 5 V (max. 100 mA, 300 mA upon request) supply voltage which the module provides at the terminals +5 V and GND can be used to power the sensors. If more voltage or supply power is needed, the sensor must be supplied externally, which means that it is absolutely necessary to ensure that this supply voltage is referenced to system ground!

3.1.1.3.5 Incremental encoder track configuration options

Mode	Channel 1	Channel 2	Channel 3	Channel 4
Single-signal mode	√	√	√	√
two-signal mode				
Single-signal mode		shows signal value 0	√	√
two-signal mode	√			
Single-signal mode	√	√		shows signal value 0
two-signal mode			√	
Single-signal mode		shows signal value 0		shows signal value 0
two-signal mode	√		√	

3.1.1.3.6 Block schematic

Incremental encoder

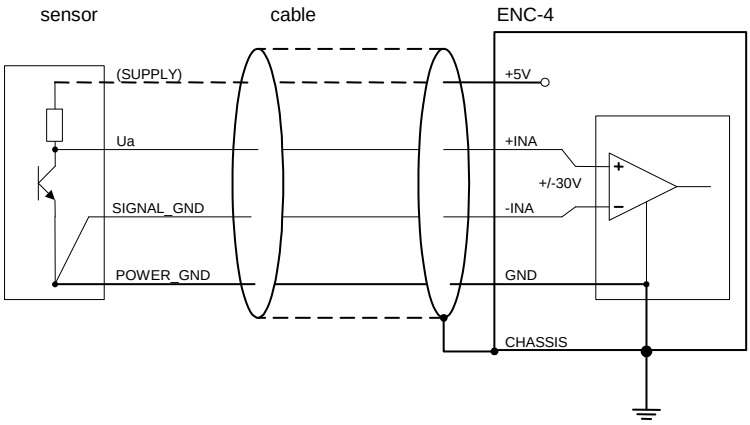


3.1.1.3.7 Connection

The pin configuration of the DSUB-15 plug 189.

3.1.1.3.7.1 Connection: Open-Collector Sensor

Simple rotary encoder sensors are often designed as an Open-Collector stage which outputs a signal which ranges between the states 0 V and SUPPLY. In this case, the switching threshold should be set to half the SUPPLY voltage:

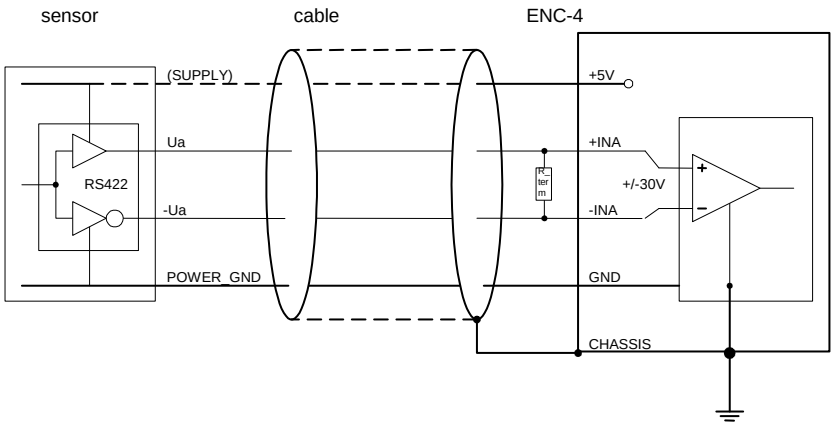


sensor with open-collector output

3.1.1.3.7.2 Connection: Sensors with RS422 differential line drivers

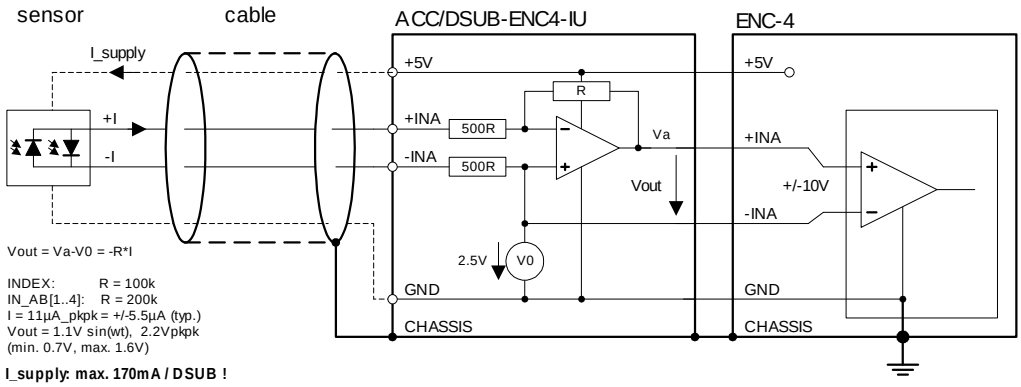
Commercially available rotary encoders are often equipped with differential line drivers, for instance as per the EIA-standard RS422. These deliver a complementary (inverse) TTL-level signal for each track. The sensor's data are evaluated differentially between the complementary outputs. The threshold to select is 0 V, since the differential evaluation results in a bipolar zero-symmetric signal: 3.8 V to 5 V (HIGH) or – 3.8 V to 5 V (LOW). Ground loops as pure common mode interference are suppressed to the greatest possible extent.

The illustration below shows the circuiting. The reflection response and thus the signal quality can be further improved by using terminator resistors.



sensor with RS422 differential output

3.1.1.3.7.3 Connection: Sensors with current signals



For a rotational encoder working with current signals, the current/ voltage terminal ACC/DSUB-ENC-4-IU 188 can be used. You can find technical specs of the ACC/DSUB-ENC-4-IU here 181.

It is possible to power the sensor from the ENC-4 module. The pertinent specifications are:

max. supply current: 320 mA

typ. encoder with 11 μA_{ss} signals:

Heidenhain ROD 456, current c: max. 85 mA per (2-signal) encoder

3.1.2 Analog outputs

The analog outputs DAC 01 to 04 provide 4 analog output channels to be used as dynamic control and actuator signals. The outputs can be defined as the results of calculations performed by imc Online FAMOS on data from combinations of measurement channels.

Highlights

- ±10 V level at max. ±10 mA driver capability and 250 Ω load
- ensured startup level 0 V without undefined transient states
- short-circuit protected against ground.

The technical specification of the module DAC-4 173.

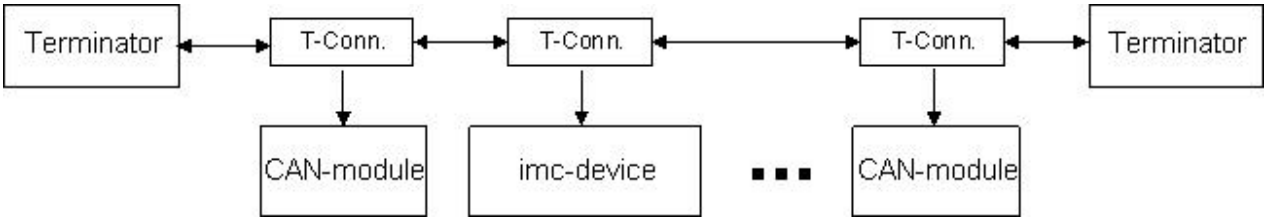
The pin configuration of the corresponding DSUB-15: ACC/DSUB(M)-DAC4 189.

3.1.3 Field bus cabling

For details about the CAN-Bus, see manual *imc DEVICES* and/or *imc STUDIO* Chapter *Field busses - CAN Bus interface*.

3.1.3.1 CAN-cabling

imc C-SERIES is equipped with 2 to 6 nodes which are joined up by a tee-junction. Connect the tee-junction to the 9-pin DSUB plug.



imc C-SERIES with connected tee-junction

Note that for a transfer rate of 1 Mbit/s to the CAN-Bus the stub line of a tee-junction may only be up to 30 cm long. In general, the wiring within imc C-SERIES is already 30 cm long. Therefore if an external tee-junction is connected, the junction must be connected straight into the terminal.

In this context it doesn't matter whether the other sensors are connected via tee-junction or not. The illustration simply shows the options available.

To the technical data and the pin configuration of the CAN-BUS interface.

3.1.3.1.1 Connecting the terminators

- Terminator-resistance is 124 Ω as per CAN in Automation (CiA).
- If terminators are connected, then between Pins 2 and 7.
- Terminators are only applied at the ends of the bus; nowhere else in the line. The bus must always end at a terminator.

Note

- With High-Speed CAN a termination on each node can be activated by software.

3.2 Miscellaneous

3.2.1 Filter settings

Filter concept of the C-series.

3.2.1.1 Theoretical background

The filter setting is especially important in a signal-sampling measurement system: the theory of digital signal processing and especially the **sampling theorem** (Shannon, Nyquist) state that for such a system, the signal must be restricted to a limited frequency band to ensure that the signal has only negligible frequency components beyond one-half of the sampling frequency ("Nyquist-frequency"). Otherwise, "aliasing" can result – distortions which cannot be removed even by subsequent filtering.

A *C-Series* device is a sampling system in which the sampling frequency, which must be set in the configuration menu, is subject to this constraint. The low-pass filter frequency selected thus hinges on how band-limited the signal to be sampled at that rate is.

The control ***AAF*** for the filter setting stands for "**A**utomatic **A**nti-aliasing **F**ilter", and automatically selects the filter frequency in adaptation to the sampling rate selected. The rule this is based on is given by:

AAF-Filter frequency (-80 dB) = sampling frequency * 0,6 = Nyquist frequency * 1,2

AAF-Filter frequency (-0,1 dB) = sampling frequency * 0,4 = Nyquist frequency * 0,8

3.2.1.2 General filter concept

imc C-SERIES system architecture is actually a **two-step** system in which the analog signals are sampled at a fixed "primary" sampling rate (analog-digital conversion with Sigma-Delta ADCs). Therefore a fixed-frequency analog low-pass filter prevents aliasing errors to this primary rate. The value of this primary rate is not visible from the outside, depends on the channel type and is generally greater than or equal to the sampling rate which is selected in the settings interface. The filter to be set is realized as a digital filter, which offers the advantage of an exact magnitude and phase shift. This is especially important for the sake of matching of channels which are jointly subjected to math operations.

If slow data rates (f_sample) are set in the system configuration, then digital anti-aliasing filters (low-pass filters) ensure compliance with the conditions for the Sampling Theorem. One distinguishes among three cases.

3.2.1.3 Implemented filters

Filter-setting "Filter-Type: without":

Only the (analog) anti-aliasing filter, matched to the primary data rate is in effect, along with digital frequency response correction downstream, which provides a steep frequency response.
This setting can be useful if maximum bandwidth reserves are to be used and there are theoretical limitations on the measured signal's spectral distribution, which justify not performing total filtering.

Filter-setting "Filter-Type: AAF":

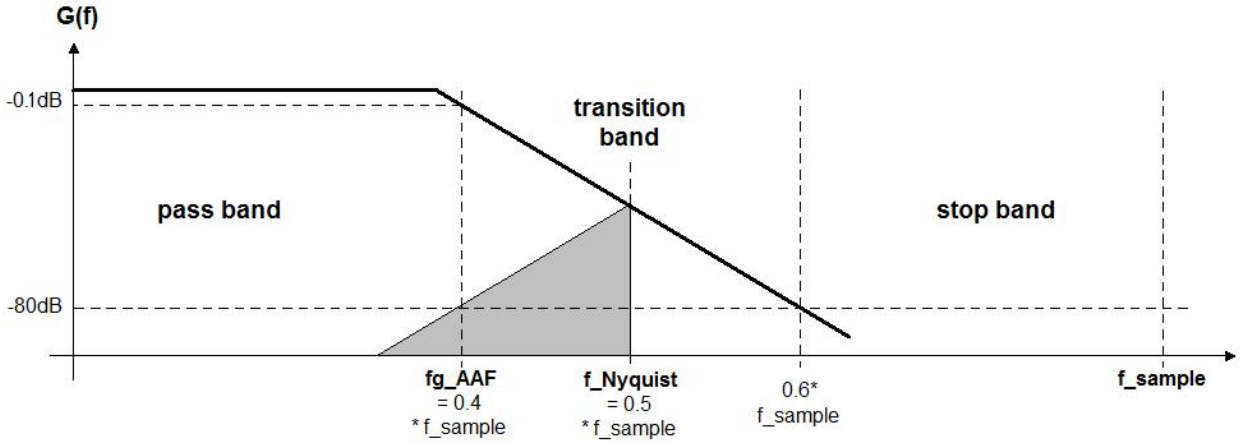
The (digital) anti-aliasing filters are elliptical Cauer filters. Their "tight" characteristic curve in the frequency range makes it possible to have the cutoff frequencies approach the sampling and Nyquist frequencies much closer without having to make a compromise between the bandwidth and freedom from aliasing.

The automatic selection of the cutoff frequency in the setting “AAF” is based on the following criteria:

- In the pass band, a maximum (AC-) gain uncertainty of 0,06% = -0,005 dB is permitted. The pass band is defined by the cutoff frequency at which this value is exceeded.
- The stop band is characterized by attenuation of at least –80 dB. This damping is considered sufficient for 16-bit systems as well, since discrete disturbance frequencies can never reach 100% amplitude: the useful input range is mostly filled by the useful signal. Otherwise, a larger range would have to be selected anyway in order to avoid overranging.
- The transition band is typically situated symmetrically around the Nyquist-frequency. This ensures that the aliasing components reflected from the stop band back into the pass band are adequately suppressed, by at least –80 dB. Remnant components from the frequency range between Nyquist-frequency and stop band limit only reflect back into the range beyond the pass band (pass band to Nyquist), whose signal content is defined as not relevant.
- The criteria stated are fulfilled with the Cauer-filters by the following configuration rule:

Filter-setting “Filter-type”: AAF:

- fg_AAF (-0,1 dB) = 0,4 * f_sample
- Characteristics: Cauer; Filter-order: 8th order



Filter-setting “Filter-type: Low-pass”:

A low-pass frequency can be set manually, which satisfies the application’s requirements. In particular, a cutoff frequency significantly below the Nyquist frequency can be set which guarantees eliminating aliasing in any case, though consequently “sacrificing” the corresponding bandwidth reserves.

with fg_AAF (3 dB)	= f_sample / 4	attenuation at Nyquist-freq.: 1/64	= -36 dB
with fg_AAF (3 dB)	= f_sample / 5	attenuation at Nyquist-freq.: 1/244	= -48 dB
with fg_AAF (3 dB)	= f_sample / 10	attenuation at Nyquist-freq.: 1/15630	= -84 dB

- Characteristics: Butterworth, 8th order (48 dB/octave)

In any case, the setting *AAF* **doesn't guarantee** aliasing-free measurement: for every particular application, check what the requirements for the filter are, and make modifications in case of heavily disturbed signals. Since the sampling and filter frequencies can be set in steps of 1 – 2 – 5, either $^1/_4$ or $^1/_5$ of the sampling rate is always available as a filter setting.

Additional filter settings options are 4th order bandpass and 4th order high-pass.

3.2.2 ICP-Expansion connector for voltage channels

3.2.2.1 IEPE (ICP)-Sensors

The following devices, in conjunction with the ICP expansion connector, are able to capture signals from current-fed sensors: C-10xx, C-12xx, C41xx and C-70xx. CS-8008 captures ICP sensor signals directly via its BNC connectors.

The IEPE (ICP)-channels are specially designed for the use of current-fed sensors in 2-wire-configuration.

IEPE, Integrated Electronics Piezo Electric, is the standard for piezoelectric transducers. IEPE (ICP)-sensors are typically employed in vibration and solid-borne sound measurements and are offered by various manufacturers as solid-borne sound microphones or accelerometers under different (trademarked) product names, such as:

PCB:	*ICP-Sensor*
KISTLER:	*Piezotron-Sensor*
Brüel&Kjaer:	*DeltaTron-Sensor*

The commonly used name ICP (Integrated Circuit Piezoelectric) is actually a registered trademark of the American manufacturer "PCB Piecotronics".

This sensor type is fed with a constant current of typically 4 mA and delivers a voltage-signal consisting of a DC-component (typ. +12 V) superimposed with an AC-signal (max. ±5 V). Typical source resistance values (internal resistance) of ICP sensors are on the order of magnitude of max. 100 Ω.

Find here notes to the measurement with current-fed sensors. 53

3.2.2.2 ICP-Expansion connector

As a special accessory for voltage channels, an ICP expansion plug (ACC/DSUB-ICP) is available. This can be used to directly connect current-fed ICP-sensors also at voltage channels.

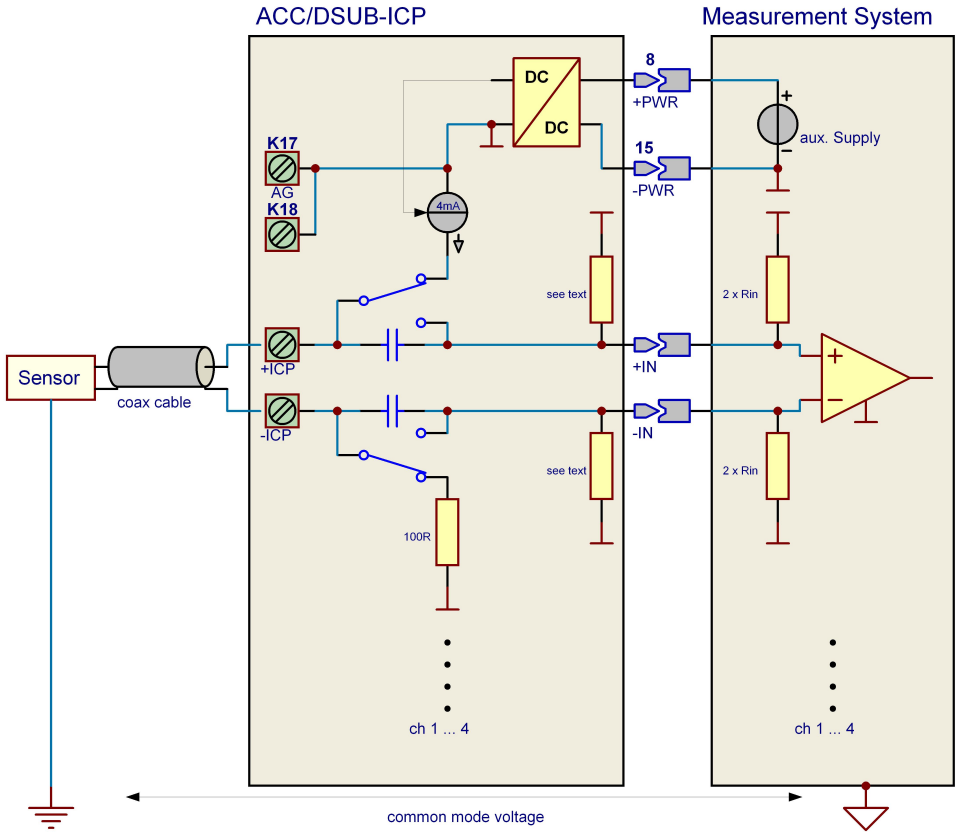
This (active) expansion plug having the same dimensions as the imc DSUB-plug, comes with additional conditioning equipment built into its housing and having the following features:

- individual current sources for the current-fed IEPE (ICP)-sensors
- per source: 4.2 mA (typ.), voltage swing: max. 25 V
- differential AC-coupling to block the signal's DC-component (approx. +12 V) typical with ICP.
- each channel can be switched to current-fed ICP measurement (AC-coupled) or DC-coupled voltage measurement.
- For the supply of this special connector, the used amplifier provides a voltage of 5 V at terminal 17 (Vcc; DSUB pin 8; pin 15 = GND). This voltage is short-circuit proof and independent of the voltage supply 109 module. The maximum load is 1.35 W. The ICP2 connector requires a maximum of 500 mW for its internal needs, the ICP4 connector requires 1 W. This means that the 5 V pin has 0.85 W or respectively 0.35 W available.

Find here the DSUB-15 pin 190 configuration.

The technical specification of the module ACC/DSUB-ICP 177.

3.2.2.3 Configuration ICP-connector



Switch position ICP:

- The AC-coupling is already provided by the ICP-plug, the voltage channel is DC-coupled.
- The input range must be adapted to the signal's AC-component, it can be adjusted within the range between
  ±5 V to ±250 mV
- The combination of the built-in coupling capacitor (2 x 220 nF corresponding to 110 nF diff.) with the impedance of the ICP-plug (2 MΩ diff.) and the input impedance constitutes a high-pass filter. When connecting the plug or sensor, be aware of the transients experienced by this high-pass filter, caused by the sensor's DC-offset (typ. +12 V). It is necessary to wait until this phenomenon decays and the measured signal is offset-free!
- When the ICP-expansion plug is used, a considerable offset can occur (in spite of AC-coupling), which can be traced to the (DC-) input currents in conjunction with the voltage amplifier's DC input impedance.
  This remainder, too, can be compensated by high-pass filtering with imc Online FAMOS.
  (Direct high-pass filtering for voltage channels is in preparation).

Switch position Volt:

- The voltage channel is DC-coupled, the current source de-coupled.
- The voltage channel's input impedance is reduced by parallel connection with the ICP-plug's impedance.

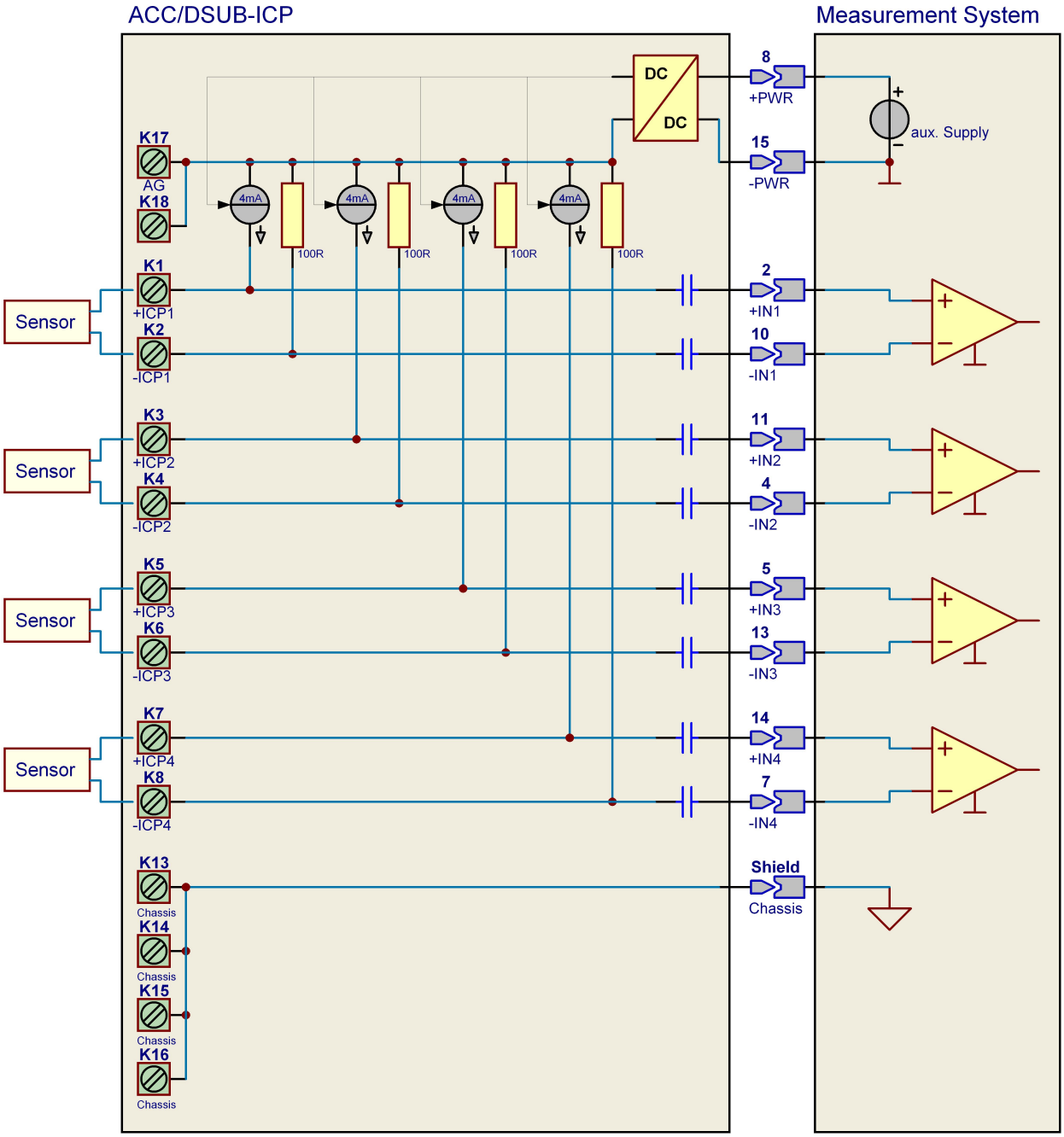
The voltage amplifiers' different input impedance values (with / without input divider) depend on the voltage range selected. The resulting high-pass cutoff frequencies and the time necessary for the 12 V-offset to decay to 10 µV are shown.

Range	diff. R_in	Result impedance	tau	fg	Settling (10 µV)
≥±5 V	1 MΩ	0.7 MΩ	73 ms	2.2 Hz	1.0 s
≤±2 V	10 MΩ	1.7 MΩ	18 ms	0.9 Hz	2.6 s

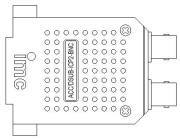
In terms of the shielding and grounding of the connected ICP-sensors, note:

- We recommend using multicore, shielded cable, where the shielding (at the plug) is connected to the plug "CHASSIS", or can be connected to the pull-relief brace in the plug.

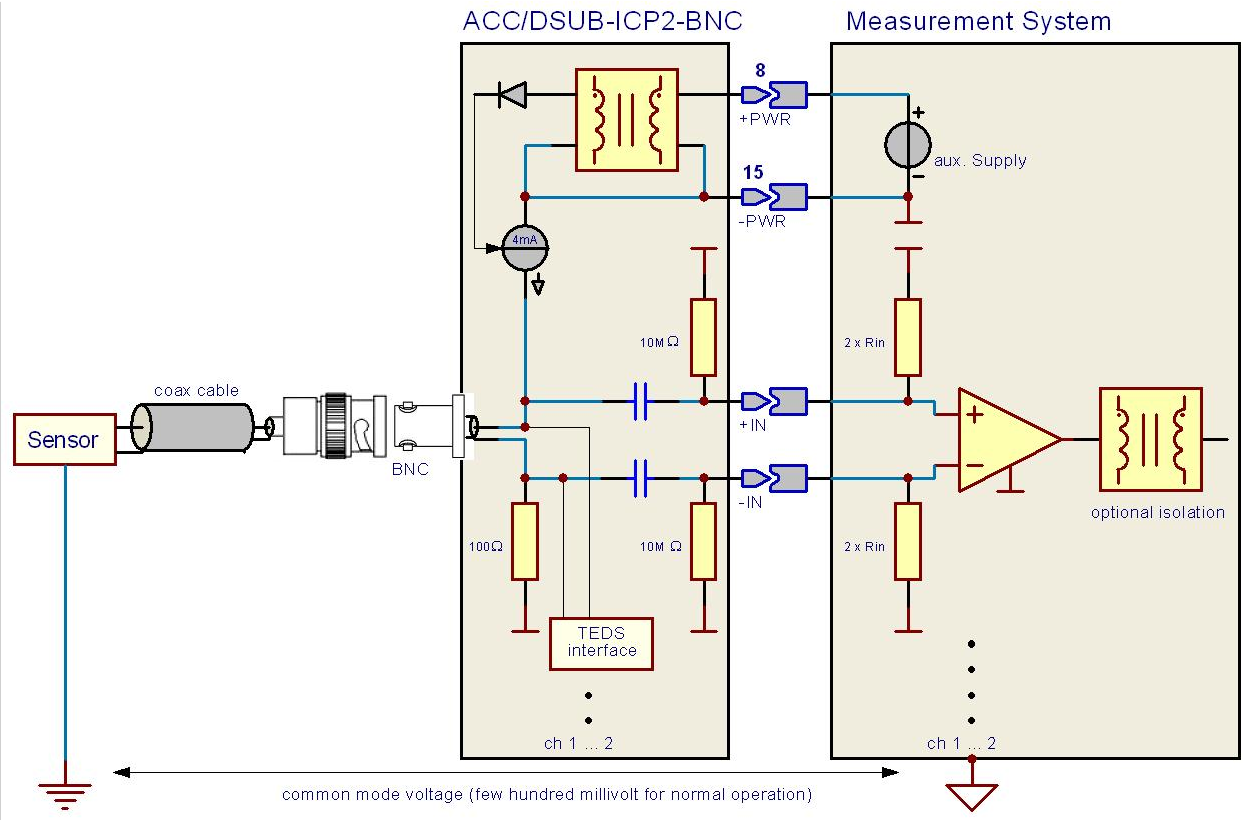
3.2.2.4 Circuit schematic: ICP-connector



3.2.2.5 ACC/DSUB-ICP2-BNC



This is a 2-channel pre-amp in the form of an imc connector, which enables two sensors having ICP-output to be connected via BNC. The available coupling types for channels to which it is connected, offer the additional entry “AC with current supply”, which makes direct connection of
ICP™ -, DeltaTron®-, or PiezoTron®-sensors possible.
The connector ensures a 4 mA current supply.



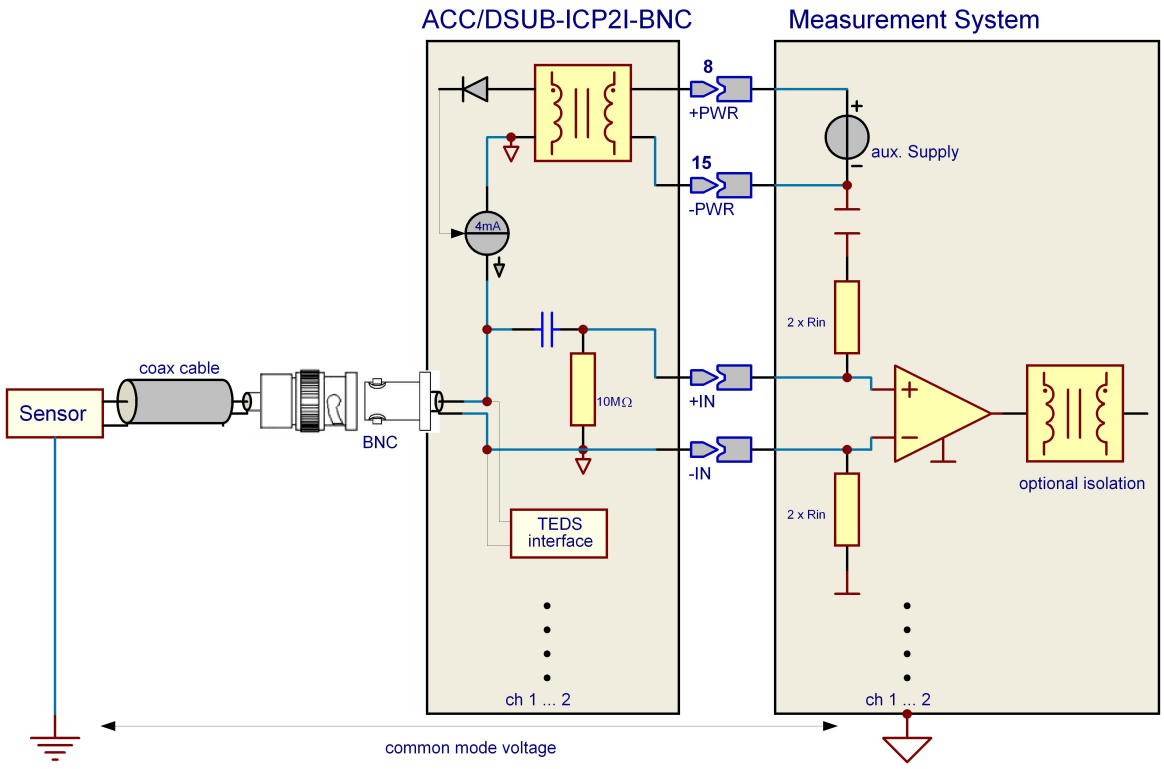
The ICP connector contains information enabling the amplifier to be set appropriately for AC coupling with current fed. If the sensor connected additionally contains TEDS information, this info is also applied. This sensor and connector information must first be imported; see also TEDS description 29.

Technical details of the ACC/DSUB-ICP2-BNC. 178

3.2.2.6 ACC/DSUB-ICP2I(M)-BNC

Isolated measurement of current fed sensors

For the purpose of connecting current-fed IEPE-sensors such as ICP™ -, DeltaTron®-, or PiezoTron®-sensors, a 4 mA supply current plus AC-coupling are provided. This ICP conditioning has channel-by-channel isolation. Due to the isolation, which offers good ground loop protection, it is possible to use grounded as well as isolated sensors. This plug can be used with isolated and non-isolated measurement inputs and is ideal for the use with voltage- and bridge measurement modules.



The notes concerning the TEDS description stated in the chapter ACC/DSUB-ICP2-BNC 71 also apply for this ACC/DSUB-ICP2I-BNC described here.

Functioning:

A LED is situated beside both BNC plugs of the connector. If the connection to the sensor is lost (probe breakage recognition and a short circuit) the LED will be on.
The current will be observed and in case of probe breakage the error (breakage) will be displayed.
During the configuration process the LEDs will shine for a short period and then switch off again.

Technical details of the ACC/DSUB-ICP2I-BNC. 179

3.2.3 External sensor supply

3.2.3.1 External +5 V supply voltage

At the DSUB-15 connector plugs, there is a **5 V supply voltage** available for external sensors or for the ICP-expansion plug. This source is not isolated; its reference potential is identical to the overall system's ground reference.

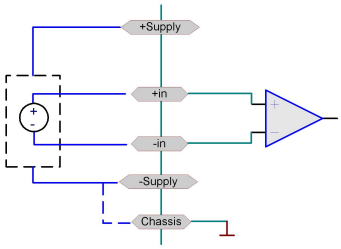
The *+5 V* supply outputs are electronically **protected** internally against short-circuiting and can each be loaded up to max. **160 mA** (short-circuit limiting: 200 mA). The sensor's reference potential, in other words its supply-ground connection is the terminal "GND".

The used pins at the DSUB-15 plug pin 8= Vcc and pin 15 = GND fulfill a double function for amplifiers, that can be used for temperature measurement. They provide the supply for the build in cold junction compensation. In this case, the 5 V supply can not be used for external sensors.

3.2.3.2 Sensor supply optional (2.5 V to 24 V)

Some modules can optionally be equipped with an adjustable sensor supply. This will not cause an enlargement of the width of those modules. Find here the technical details of the sensor supply 184.

Important: The settings are made via software interface. Make sure that the sensor supply is not set too high ***before*** connecting a sensor. Otherwise, both the sensor could suffer damage.



The supply is unipolar and is contacted at the DSUB-15 terminals +SUPPLY and -SUPPLY. The voltage can be set globally between 2,5 V and 24 V and is valid for a group of 16 channels (CH01...CH16, CH17...CH32, etc.)

A bipolar supply voltage of ±15 V instead of the unipolar 15 V is available special request. With this option the pin 6 is the reference with the connector.

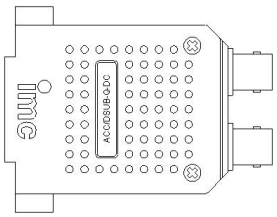
In the standard package, the sensor supply voltage is in this version not isolated (to CHASSIS).

This is also recommendable in most cases: If an isolated, active sensor is both fed with an isolated supply and measured with an isolated channel, then (due to isolation drift or capacitive interference coupling) an uncontrolled common mode voltage will emerge unless a common mode voltage is imposed from outside (or, for instance, by targeted grounding) which may be too strong interference to suppress. Only if the sensor to be supplied with power is already affected with a common mode voltage due to the measurement setup, or if the –SUPPLY return lines are already exposed to uncontrolled ground loops, an isolated sensor supply may be advisable.

The supply voltage is set on each channel group (CH01...CH16, CH17...CH32, etc.) and does apply to all inputs of this group. For the number of channels per group is depending on the type of device.

3.2.4 DSUB-Q2 charging amplifier

The charge amplifier DSUB-Q2 serves to adapt a piezoelectric sensor's charge output signal to voltage measurement inputs of the amplifier (find here the supported amplifier 180). The DSUB-Q2 contains two miniature charge amplifiers which carry out a transformation of electrical charge to voltage. It is suitable for quasi-static (in DC-coupling-mode) as well as dynamic measurements. It can be used to record measurement readings of forces, pressures and accelerations.



charging amplifier DSUB-Q2

This is a 2-channel pre-amplifier in the form of an imc connector which enables connection of two charge sensors via BNC.

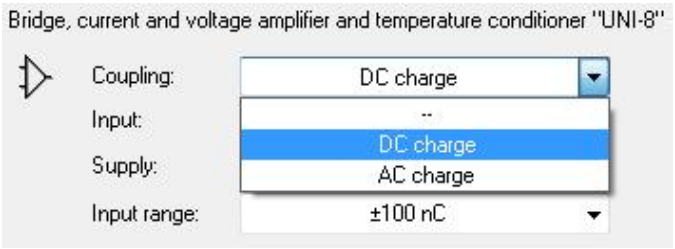
It adds the entries "DC charge" and "AC charge" to the coupling types available for the connected channels. Since only charges can be measured at the channels concerned as long as the connector is connected, the other coupling types are not available.

Technical details: ACC/DSUB-Q2 connector. 180

Once the DSUB-Q2 terminal is connected, the channels used are configured by

importing the sensor information . Otherwise,
this error message appears during the preparation process:

```
"The required imc plug with charging amplifier DSUB-Q2 is not connected! Error number: 6330"
```



imc DEVICES\amplifier tab: DSUB-Q2 settings with C-70xx-1 [-N]

Now the channels are set to charge coupling. All other couplings such as current measurement, bridge measurement etc. are now no longer available.

Note

- The ACC/DSUB-Q2 plug is not completely compatible with the UNI-8 and the DCB-8:
  max. two plugs can be connected to those amplifiers/plugs.
  Background: the UNI-8 is equipped with a current limiting unit in the supply line (Vcc) to the plugs. This limits the max. total current of all four DSUB plugs of the amplifier. The current limit is not reached with four plugs, but the voltage is due to the internal resistance of the supplied plugs too small to guarantee a confident functionality.
  With the UNI2-8 and the DCB2-8 this problem does not exist, because each plug is supplied individually.
- The charge amplifier itself is not TEDS-capable, so it is not possible to import sensor information from the connected charge sensors. For this reason, the button Import sensor data from sensor and set channel causes the function Import connector data and set channel to be performed in this case. However, if the opposite case occurs, namely that charge coupling is set but no charge amplifier is connected to the corresponding channel, the following error message provides notification of this:
  `"The required imc plug charging amplifier DSUB-Q2 is not connected! Error number: 6333"`
- Loading an experiment created with the imc DEVICES 2.6 in the 2.7 software version, you are supposed to read the channels with charge amplifier again.

3.2.5 LEDs and BEEPER

6 Status-lamps (LEDs, on the device front panel) and a ***beeper*** are provided as additional visual and acoustic "output channels". They can be used just as standard output channels in Online FAMOS by assigning them the binary values "0" / "1" or functions taking the Boolean value range.

Interactive setting and Bit-window display for these output channels is neither especially useful nor supported.

It is not possible to deactivate the beeper by software. The beeper indicates a starting buffering period of the UPS.

3.2.6 Modem connection

By default, an external modem is connected via the 9-pin DSUB plug (female). If your system comes with a built-in modem, there is an RJ45 socket instead. Normal telephone connection plugs are smaller than standard RJ45 plugs, however they will fit without an adapter.

The pin configuration of the DSUB-9 plug (female).

Note

- If your system is equipped with a built-in modem then, Don't mistake the modem socket for the Ethernet socket used to connect to a computer network.

3.2.7 SYNC

For a synchronized measurement use the SYNC terminal. That connector has to be connected with other imc devices or a DCF77 antenna.

Note

- When using multiple devices connected via the Sync terminal for synchronization purposes, ensure that all devices are the same voltage level. Any potential differences among devices may have to be evened out using an additional line having adequate cross section. Alternatively it is possible to isolate the devices by using the module ISOSYNC.
- If the SYNC plug at your device is marked with a yellow ring surrounding the BNC connector it is already isolated and it is protected against potential differences.
- See also chapter Synchronization in the imc DEVICES manual.

Technical details: synchronization

3.2.7.1 Optical SYNC Adapter: ACC/SYNC-FIBRE

One fundamental feature of all imc measurement devices, whether belonging to the device families imc CRONOS*flex*, imc CRONOS*compact*, imc CRONOS-SL, imc CRONOS-PL, imc SPARTAN, imc BUSDAQ or imc C-SERIES, is their ability to synchronize multiple devices, even of differing models, and to operate them all in concert. The synchronization is typically accomplished by means of a Master/Slave process via the electrical SYNC-signal, which terminates on the devices at a BNC socket.

In areas of high electrical interference, or where long-distance signal transmission is needed, the signal can be conducted via fiber optic cabling with total isolation and no interference. For this purpose, the externally connectable optical SYNC adapter ACC/SYNC-FIBRE is available.

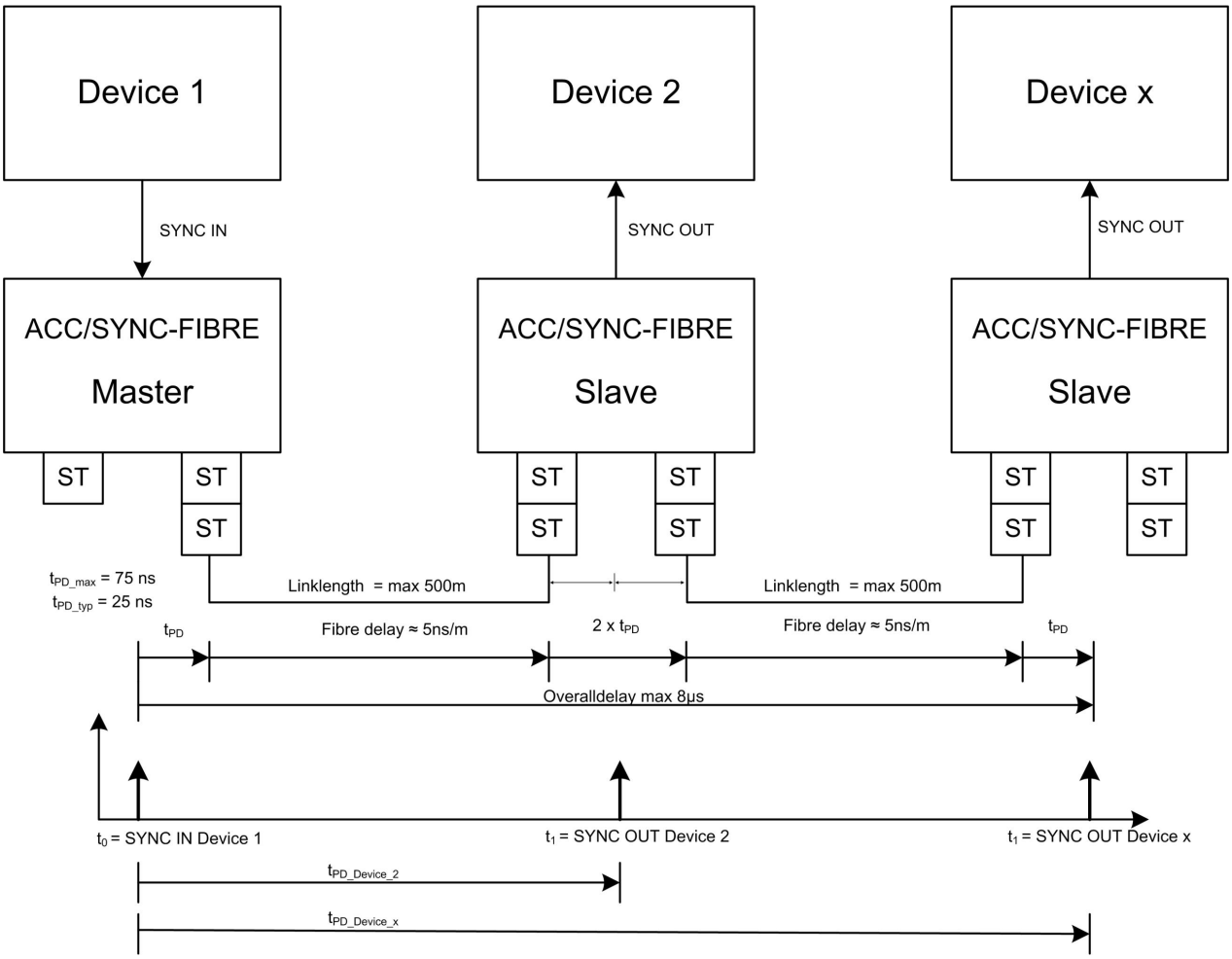
When this adapter is used, the BNC socket is not, but rather one of the DSUB-9 sockets for the GPS, DISPLAY or MODEM, which then conducts both the isolated electrical SYNC signal and additionally a supply voltage which is required by the adapter, as well as supplying directional indication (Master to

Slave).

For this reason, any imc measurement devices used must be remodeled in accommodation to one of the DSUB-9 sockets. Once either the MODEM or the GPS socket has been remodeled, it is no longer usable for its original purpose. For the GPS socket, this does not apply. Even parallel operation is possible (via Y-cable), if the GPS-data are only used for the position data and the adapter is used for the SYNC signal.

For whichever signal (adapter or BNC) is currently connected, both the electrical and the optical mode can be used, however not both at the same time.

The plug is designed for the extended environmental range. The imc measurement devices used with this adapter require some modification.



Find here technical details: ACC/SYNC-FIBRE 182

3.2.8 IRIG-B module

This external IRIG-B module can convert a time signal in IRIG format to the GPS format NMEA 0183 and thus be used for synchronization of different devices.

The extension module exclusively supports amplitude modulated IRIG signals according to the standards IRIG-B1xx! This is why it can be used both to upgrade older imc device generations which provided no IRIG-B support at all, and to enhance current imc device generations with additional capabilities regarding modulated signals: While many up-to-date imc device series (CRFX, CRC, C-SERIES-N) offer IRIG-B synchronization via their standard BNC synchronization plug as a standard feature (including DCF-77 / IRIG-B auto-detection), this path only supports direct unmodulated TTL-signals (IRIG-B0xx).

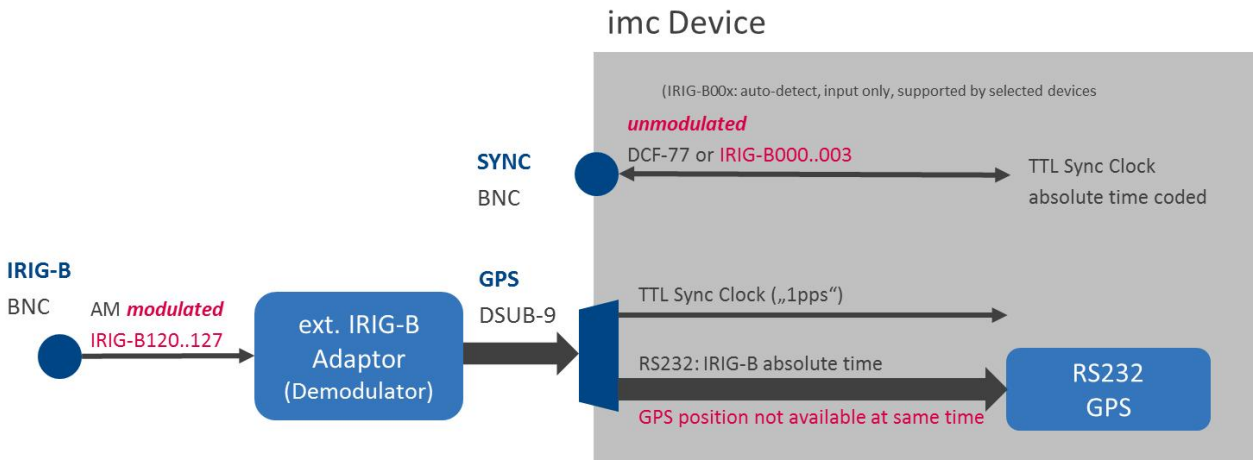
The definition of the various IRIG time codes is specified in the IRIG standard 200-98. This adapter module supports sub-standards IRIG-B120 through B127. These are characterized by 100 pulses per second, AM (amplitude-modulated) sinusoidal signal, 1 kHz carrier frequency, BCD Time-of-Year.

The module's rear panel holds the DSUB-9 plug, which is connected to the measurement system's GPS plug via the included RS232 extension cable. The pinout of the DSUB-9 plug directly conforms to the "GPS" connectors pin configuration, which is uniform to imc measurement systems.

When using the IRIG-B adapter in conjunction with this GPS port, absolute time information is captured via this RS232 interface, and additionally, synchronization of the device's system clock is performed by means of an additional clock signal ("1 pps") provided on a dedicated pin of the DSUB-9 terminal. While this occupies the port, simultaneous capture of GPS geo positioning information is not supported at the same time.

Note

The operating software (imc STUDIO / imc DEVICES) will denote the used synchronization type as "GPS", simply because the respective port is used to interface the IRIG-B module.



The module's front panel has one BNC plug and two LEDs. The LOCK LED shines when the input signal is synchronized with the IRIG-B module. If the input signal is not valid or not synchronized with the IRIG-B module, the FAIL LED shines.

The IRIG-B module comprises a realtime clock (RTC) with a backup battery, which is set to time and date according to the IRIG B-signal received. If the IRIG B year codes received equal "00" (depending on used sub-standard) these are ignored and only RTC time and day values are set, while the year continues to reflect the value resulting from counting since the last update with a valid year number. This means that the year number is incremented at the turn of the new year.

To monitor an imc measurement system's synchronization status, it is possible to use the imc Online FAMOS function "IsSynchronized()". Its return value is "1" if the device is synchronized to an external time reference; otherwise, a "0" is returned.

Loss of the external time signal is detected within 1 – 2 seconds. However, the process of restoring synchronization can last approx. 20 – 25 seconds.

Technical Specs of IRIG-B 183.

The IRIG-B module weighs about 55 g. Optionally, the module can be factory installed in a measurement system.

3.2.9 GPS

At the nine-pin GPS socket it is possible to connect a GPS-receiver of the type Garmin GPS18LVC, GPS18-5Hz etc. which enables absolute synchronization to GPS time. If the GPS-mouse has reception, the measurement system synchronizes itself automatically.

Also, if a valid DCF-77 signal is applied at the Sync-socket, the first signal which the hardware recognizes as valid is accepted.

GPS signals can be proceeded without Online FAMOS Professional. The time counter DCF77 or GPS can be selected by software. It is possible to evaluate all GPS information which can be retrieved in the system via the process vector. By means of imc Online FAMOS, this information can be processed further.

The available GPS information includes:

- **pv.GPS.course:** course in °

- **pv.GPS.course_variation:** magnetic declination in °
- **pv.GPS.hdop:** Dilution of precision for horizontal
- **pv.GPS.height:** height over sea level (over geoid) in meter
- **pv.GPS.height_geoidal:** height geoid minus height ellipsoid (WGS84) in meter
- **pv.GPS.latitude; pv.GPS.longitude:** latitude and longitude in degree. (Scaled with 1E-7)
- **pv.GPS.pdop:** Dilution of precision for position
- **pv.GPS.quality:** GPS quality indicator
  0 Invalid position or position not available
  1 GPS standard mode, fix valid
  2 differential GPS, fix valid
  …
- **pv.GPS.satellites:** number of used satellites.
- **pv.GPS.speed:** speed in km/h
- **pv.GPS.time.sec**:As of imcDevices Version 2.6R3 SP9, pv.GPS.time.sec records the number of seconds since 01.01.1970 00:00 hours UTC! For this reason, it is no longer possible to assign the value to a Float-format channel without loss of data. This count of seconds can be transformed to absolute time under Windows and Linux.To do this, use the function below
  `MySeconds = CreateVChannelInt( channel, pv.GPS.time.sec)`
- **pv.GPS.vdop:** Dilution of precision for vertical
  see e.g.: http://www.iota-es.de/federspiel/gps_artikel.html (German)

for internal use only:

- pv.GPS.counter
- pv.GPS.time.rel
- pv.GPS.test
- pv.GPS.time.usec

Create a GPS data stream

```
slow = Mean( DIn01, 1, 10 )
latitude  = CreateVChannelInt( slow, pv.GPS.latitude)
longitude = CreateVChannelInt( slow, pv.GPS.longitude)
quality    = CreateVChannel( slow, pv.GPS.quality)
satellites = CreateVChannel( slow, pv.GPS.satellites)
```

From version imc DEVICES 2.8, GPS signals are available as fieldbus channels

Note

- **pv.GPS.latitude** and **pv.GPS.longitude** are scaled as **integer 32 with 1E7**. They must be proceeded as integer channels, otherwise precession will be lost. If the virtual channel is created by a addition with a channel, the result must be multiplied by 10^{-7}:
  latitude = Channel_01*0+pv.GPS.latitude *1E-7
- Pin configuration of the DSUB-9 connector

3.2.10 Operation without PC

To operate your imc measurement device , you don't necessarily need a PC. Your device will start the measurement independently, if an autostart has been prepared. Using the optional display unit, you can use its keyboard to control the measurement. The Display can be used to output the accumulating measured values.

The display serves as a comfortable status indicator device and can replace or complement the imc operating software (imc STUDIO / imc DEVICES) when it comes to controlling the measurement. It can even be used where no PC can go, e.g. at temperatures of -20°C or +70°C.

The display can be connected or disconnected at any time without affecting a running measurement.

This makes it possible, for example, to check the status of multiple devices running simultaneously one at a time.

Interaction with the measurement device is provided by means of virtual Display variables or bits, which can either be evaluated to obtain status indications or modified in order to influence the measurement process.

3.2.10.1 Graphical display

The optional display screen enables interaction between the user and a running measurement process by posting read-outs of system states and allowing parameter adjustments via the membrane touch panel.

If the measurement device is prepared for opening a particular configuration upon being activated, it's possible to carry out the measurement without any PC. The Display serves as a convenient status indicator and can replace or supplement imc DEVICES for process control purposes.

The Display can be connected or disconnected at any time without disturbing a running measurement. This makes it possible, for instance, to check the status of multiple running devices in succession.

The Display's interaction with the measurement device is handled by means of virtual Display variables or bits, which can either be evaluated for the purpose of status indication or set in order to affect the measurement process.

Detailed descriptions of the functions are presented in the chapter *Display* of the imc operating software manual. The external Display:

- 320 x 240 pixels in 65536 colors
- Housing dimensions approx. 306 mm x 170 mm x 25 mm
- Readout screen size: approx. 11.5 cm x 8.6 cm
- Bore diameter for Display fixing: diameter core hole 5.11 mm; diameter exterior 6.35 mm (1/4" - 20 UNC)
- Weight: approx. 1.0 kg

Note

- The Display is controlled by a serial RS232 connection. The update frequency can't be changed. It depends on the load of the imc DEVICES, which is at best 15 Hz.

Technical details of the imc Graphics Display 176.

3.3 CS-1016 [-N], CL-1032 [-N]

CS-1016 [-N] and CL-1032 [-N] are 16- and 32-channel measurement devices, respectively, for voltage and current measurement tasks, with sampling rates of up to 20 kHz per channel.

The input channels are differential and equipped with per-channel signal conditioning, including filters. The devices come with the following analog measurement channels: voltage, current and current fed sensors e.g. IEPE (optional)

The technical specs of the CS-1016, CL-1032 139.

The devices come with 16 (CS) or 32 (CL) differential, non-isolated input channels which can be used for measuring voltage 81. In addition, current 81 measurement by means of a shunt plug and the use of an IEPE (ICP) 81-expansion plug are provided for. The channels each come with 5th order ("analog", fixed-configuration) anti-aliasing filters, whose cutoff frequency is 6.6 kHz.

3.3.1 Voltage measurement

- Voltage ranges: ±250 mV, ±1 V, ±2.5 V, ±10 V

The input impedance is 10 MΩ referenced to system ground or 20 MΩ differential. The inputs are DC-coupled. The corresponding connection terminal is designated ACC/DSUB(M)-U4 189

3.3.2 Current measurement

- Current ranges: ±5 mA, ±20 mA, ±50 mA

For current measurements, a special plug with a built-in **shunt** (50 Ω) is needed ACC/DSUB(M)-I4 189.

For current measurement with the special shunt-plugs **ACC/DSUB(M)-I4**, input ranging only up to **max. ±50 mA** (corresponding to 2 V or 2.5 V voltage ranges) **are permitted** due to the measurement shunt's limited power dissipation in the case of static long-term loading.

Note

Configuration is carried out in the voltage mode, but an appropriate scaling factor is entered which allows direct display of current values (0.02 A/V = 1/50 Ω).

3.3.3 Current fed sensors

At the connection sockets, a permanent 5 V supply voltage for external sensors 73 or for the ICP expansion connectors ACC/DSUB-ICP 68 and ACC/DSUB-ICP2-BNC 71 is available. This voltage source is grounded to the measurement device's frame.

The description of measurement with ICP sensors is presented here. 68

3.3.4 Bandwidth

The channels' **max. sampling rate** is 20 kHz (50 µs sampling interval). The **analog bandwidth** (without digital low-pass filtering) is 6.6 kHz (-3 dB).

3.3.5 Connection

The analog channels of C-10xx [-N] devices are equipped with four DSUB-15 connectors (4 channels / connector).

Pin configuration of the DSUB-15 189

3.4 CS-1208-1 [-N], CL-1224-1 [-N]

CS-1208 [-N] and CL-1224 [-N] are 8- and 24-channel universal measurement device , respectively, for voltage and current measurement tasks (20 mA), with sampling rates of up to 100 kHz per channel. The CS-1208-**1** [-**N**] and the CL-1224-**1** [-**N**] measurement system is an advanced development of the CS-1208 and CL-1224 and differ not only in the bandwidth (CS-1208 and CL-1224: 14 kHz; CS-1208-1 [-N] and CL-1224-1 [-N]: 48 kHz). Unless any limitations are mentioned, the following description applies for both, the predecessor and the advanced development.

Their 50 V input range and their very low noise voltage in particular destine these devices for highest-performance voltage measurement. The input channels are differential and equipped with per-channel signal conditioning, including filters.

The technical specs of the CS-1208-1 [-N], CL-1224-1 [-N] 141.

3.4.1 Voltage measurement

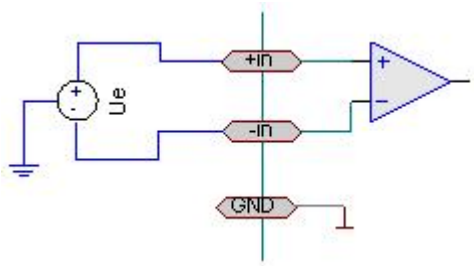
- Voltage: ±5 mV to ±50 V

In the voltage ranges ±50 V and ±20 V, a voltage divider is in operation; the resulting input impedance is 1 MΩ. In the voltage ranges ±10 V to ±5 mV, by contrast, the input impedance is 20 MΩ. When the device is deactivated, it drops to about 1 MΩ.

The input configuration is differential and DC-coupled.

3.4.1.1 Voltage source with ground reference

The voltage source itself already is referenced to the device's ground. The voltage source is at the same potential as the device ground.



Example: The unit is grounded. Thus, the input GND is at ground potential. If the voltage source itself is also grounded, it is referenced to the device ground.

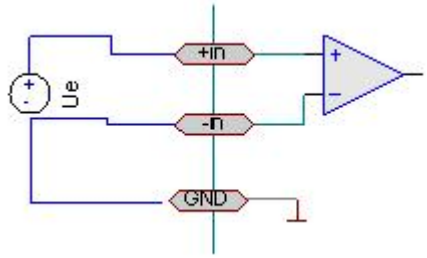
It isn't any problem if, as it may be, the ground potential at the voltage source deviates from the ground potential of the device itself by a few degrees. The maximum permitted common mode voltage must not be exceeded.

Note

In this example, the negative signal input -IN may not be connected to the ground contact GND in the device. Otherwise, a ground loop would result, through which interference could be coupled in.
In this case, a true differential (but not isolated!) measurement is performed.

3.4.1.2 Voltage source without ground reference

The voltage source itself has no reference to unit's ground, but instead, its potential floats freely vis-à-vis the device ground. If a ground reference cannot be established, it's also possible to connect the negative signal input –IN to the ground contact GND.

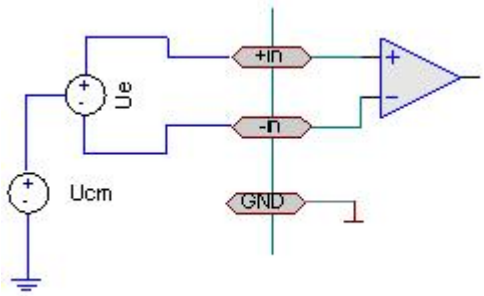


Example: A voltage source which isn't grounded (e.g. a battery) and whose contacts have no connection to ground potential is measured. The device is grounded.

Note

When –IN and GND are connected, be sure that the signal source's potential can actually be drawn to the device ground's potential without an appreciable current flowing. If the source can't be brought to that potential level (because it turns out to be at fixed potential after all), there is a risk of permanent damage to the amplifier. If IN and GND are connected, a single end measurement is performed. This isn't a problem unless a ground reference already existed.

3.4.1.3 Voltage source at other, fixed potential



In the input ranges <20 V, the common mode voltage U_{cm} must lie within the range ±10 V. It is reduced by one-half of the input voltage.

3.4.1.4 Voltage measurement: With taring

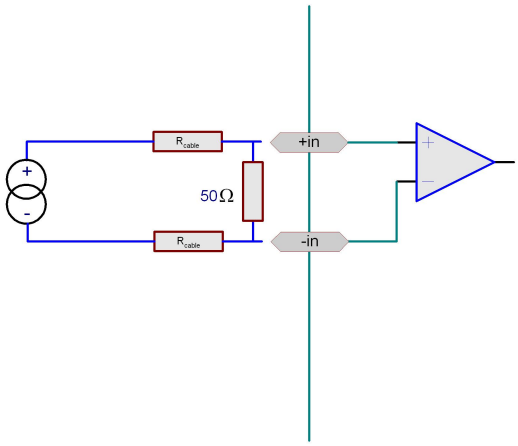
With voltage measurement, it's possible to tare a zero offset to restore correct zero. For this purpose, select the menu item *Settings -> Amplifiers (balance etc.)…*, and on the screen's index card *Common*, under *Balancing*, select the option *Tare* for the desired channel. The input range correspondingly is reduced by the amount of the zero adjustment. If the initial offset is so large that it's not possible to adjust it by means of the device, a larger input range must be set.

3.4.2 Current measurement

- Current: e.g. ±50 mA to ±1 mA

For current measurement, the DSUB connector ACC/DSUB-I4 must be used. This plug is not included in the standard package. It contains a 50 Ω shunt.

In addition, voltage can be measured via an externally connected shunt. The appropriate scaling must be set in the user interface. The value 50 Ω is only a suggestion. The resistance should be sufficiently precise. Make not of the shunt's power consumption.



In this configuration, too, the maximum common mode voltage must be located within the range: ±10 V. This can generally only be assured if the current source is also already referenced to ground.

If the current source has no ground reference, there is a danger of the unit suffering unacceptably high overvoltage. It may be necessary to create a ground reference, for instance, by grounding the current source.

Note

Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc DEVICES interface.
The scaling factor is entered as 1/R and the unit as A (0.02 A/V = 1/50 Ω).

3.4.3 Current fed sensors

At the connection sockets, a permanent 5 V supply voltage for external sensors 73 or for the ICP expansion plugs ACC/DSUB-ICP 68 and ACC/DSUB-ICP4 71 is available. This voltage source is grounded to the measurement device's frame.

The description of measurement with ICP sensors is presented here. 68

3.4.4 Bandwidth

The channels' **max. sampling rate** is 100 kSamples/s (10 µs sampling interval). The **analog bandwidth** *CS-1208* and *CL-1224* (without digital low-pass filtering) is 14 kHz (-3 dB) and the analog bandwidth of the *CS-1208-1* and *CL-1224-1* is 48 kHz (-3 dB).

3.4.5 Connection

Pin configuration of the DSUB-15 189

3.5 CL-2108

CL-2108 is a measurement device for measurement of network power quality. This module enable direct measurement of voltages of up to ±**1000 V** and offers connection terminals for current probes.

The following measurement channels are available:

- voltages of up to ±1000 V with a protection class of up to CAT II
- currents of up to 10 A with current probes respectively low voltages
- currents of up to 10 kA with using Rogowski-Coils

Technical details: CL-2108 143.

3.5.1 High-voltage channels

The high-voltage channels are each equipped with an galvanically isolated amplifier. They enable direct measurement of voltages of up to ±**1000 V** (peak values), in accordance with the protection class CAT II.

The measurement signal is connected directly to the device via a safety banana jack.

Warning

Do not damage the safety seal!
Each high-voltage module of your CL-2108 module was inspected for compliance with the safety guidelines per DIN EN 61010-1 prior to delivery, and subjected to a high-voltage test. The module is sealed after having passed these final tests.
If the safety seal is damaged, safe work cannot be ensured.
Any intervention, for instance temporary removal of the module, makes re-inspection for safety.

3.5.1.1 Voltage measurement

- Voltage: ±1000 V to ±2.5 V in 9 different ranges

The inputs are DC-coupled and have a permanent input impedance of 2 MΩ. The differential response is achieved by means of the isolated configuration.

For the voltage measurement at common low voltage systems there is a reserve of the displayed value, therefore imc recommends the choice of the following measurement ranges:

- range = 250 V for 230 V-system +25%
- range = 500 V for 400 V-system +40%

3.5.2 Current measurement channels

Those current measurement channels are specially for the use of current transducers with voltage output. Current Probes 86 and Rogowski Coils 87 can be transducer, which perform a power voltage conversion. Besides this kind of current measurement there is also the measurement of low voltage 90 signals possible within the respective measurement ranges. The following ranges are available ±5 V to ±250 mV. The differential inputs are DC-coupled and galvanically isolated.

Suitable current probe and Rogowski Coils can be delivered.

Note

- Use only current probes provided by imc, or have your own current probes modified by our customer service. Only then can error-free functioning be assured. imc will not accept responsibility for disturbances or damage sustained by the device if unauthorized probes are used.
- Whenever you connect a new current probe, read its TEDS information. The TEDS data are recorded along with the experiment and therefore need not be imported each time the same equipment is activated. See also the notes for making settings in the imc software 89.
- Amplitude and angle error of the external measurement transducer influence the measurement result and this mostly effect the power quality measurement.

3.5.2.1 Current measurement using Current Probes

Current Probes are compactly structured, electrically isolated sensors shaped like clamps, by which currents can be measured simply by encircling the conducting wire, without interrupting the circuit. The current under investigation is converted to a proportional voltage signal. Active sensors such as compensation transducers require their own power supply. In most cases, this is already provided by a battery in the Current Probe. Like Current Probes, Rogowski Coils enable contact-free measurement of current in a conductor by simply encircling it. In contrast to active Current Probes, Rogowski Coils don't require a power supply, but they can only measure AC-currents. To be exact, they measure the change in current, which makes integration of the signal necessary.

In both application cases, configuration of the measurement channel according to the type used is necessary. The Current Probes offered by imc come this way and will be detected by the imc operating software.

See also the notes on making settings in the imc operating software 89.

Warning

- The measurement inputs are high-impedance and are not intended for direct connection of current transducers.

- **The measurement signal can be accompanied by dangerous contact voltages.**
  Please use only safety plugs.

3.5.2.2 Current measurement using Rogowski Coil

A Rogowski coil encircles a current conductor thus encompassing its magnetic flux field. By means of appropriate measurement engineering technology which is able to take the time integral of the encircled output voltage, it is possible to measure the current conducted. The measurement inputs of the HV2-2U2I are able to perform this integration when the Rogowski coil is connected with a TEDS or if the corresponding sensor information from the imc SENSORS database is used. (The HV2-2U2I is a successor model of the HV-2U2I.)

The Rogowski coil consists of a single wire which winds along the entire length of the loop. Due to design issues, not the whole magnetic field of the Rogowski coil is measured, since the winding stops at the coil's "node" (or the "buckle" of the loop/"belt"). This gap and the associated incomplete measurement of the magnetic field cause a certain measurement error whose magnitude depends on the conductor's position relative to the node; the closer the node, the greater the error.

As you can see in the following figure, the measurement error depends on where the conductor is located within the loop, in terms of the distance from the node at which the conductor passes perpendicularly through the plane of the loop. It can be shown that the optimum location for the conductor is across from the node.

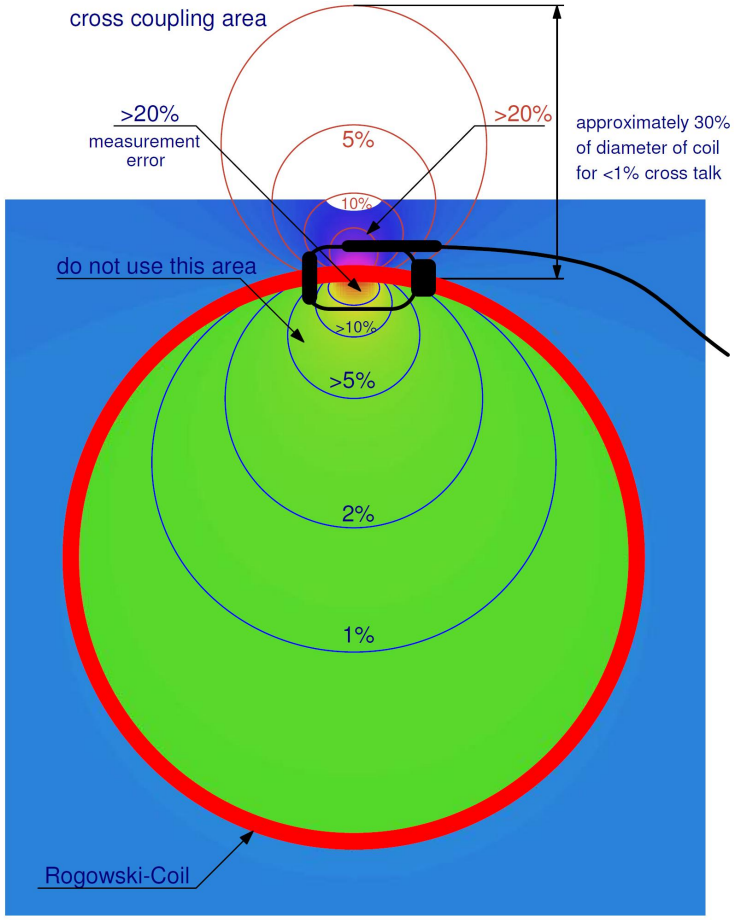


figure 1: measurement error in a Rogowski coil

Since the coil does not completely surround the conductor, only a part of the current is measured. In the one-third of area opposite from the node, the amount measured is ca. 98%. The sensor's sensitivity is calibrated at factory in the optimum position and is saved in the TEDS which is installed in the coil. This value is automatically used by the measurement system as the correction value. Thus, the measurement error at the optimum conductor position is less than 0.5%. The measurement uncertainty for HV2-2U2I is significantly less. (Bending the coil into an ellipse is not recommended.)

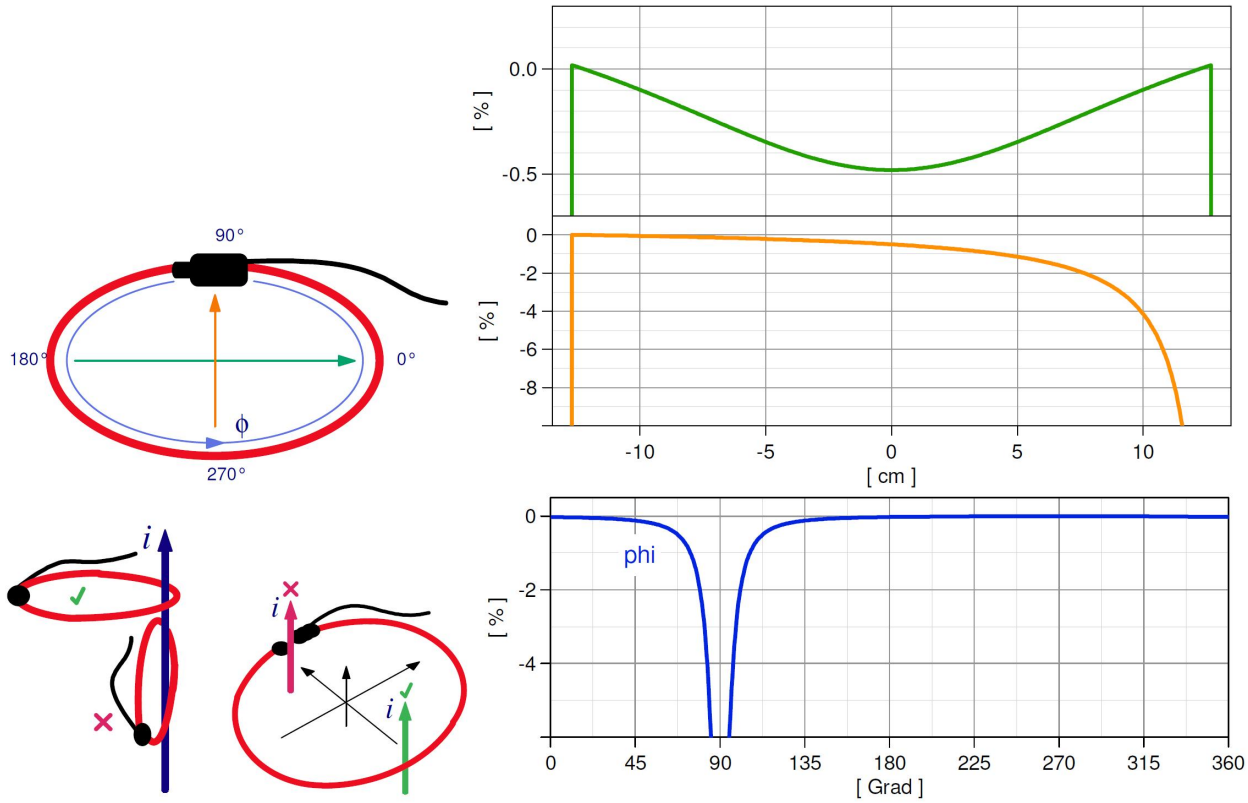


figure 2: location-dependent measurement error in a Rogowski coil for selected distances

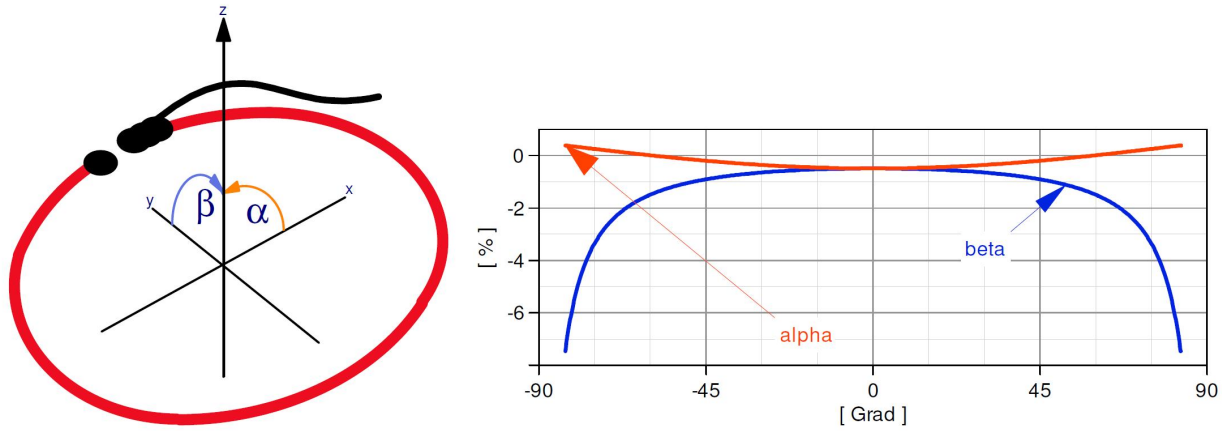


figure 3:
Location-dependent measurement error in a Rogowski coil for different angles of inclination to the loop plane

An angle between the axis of the conductor and the plane of the loop also causes measurement error – especially if it causes the node to get near the conductor. This relationship is graphed in Fig. 3 for rotation in the angle b. (Figures 1 through 3 apply to a coil length of 80 cm / 32 inch. For loops having a length of 40 cm / 16 inch, the position dependency is greater and is approximated by Fig. 1 for equally-sized nodes.)

If there is an additional conductor in proximity to the node, its magnetic field also affects the sensor and thus distorts the measurement. For this reason, the node should be positioned in such a way as to maximize its distance from the conductor. See Fig. 1.

Note

For small measurement errors, observe the following rules:
- Place the conductor across from the loop node.
- Secure the loop in a plane perpendicular to the axis of the conductor.
- Keep the greatest possible distance between the loop node and other conductors.

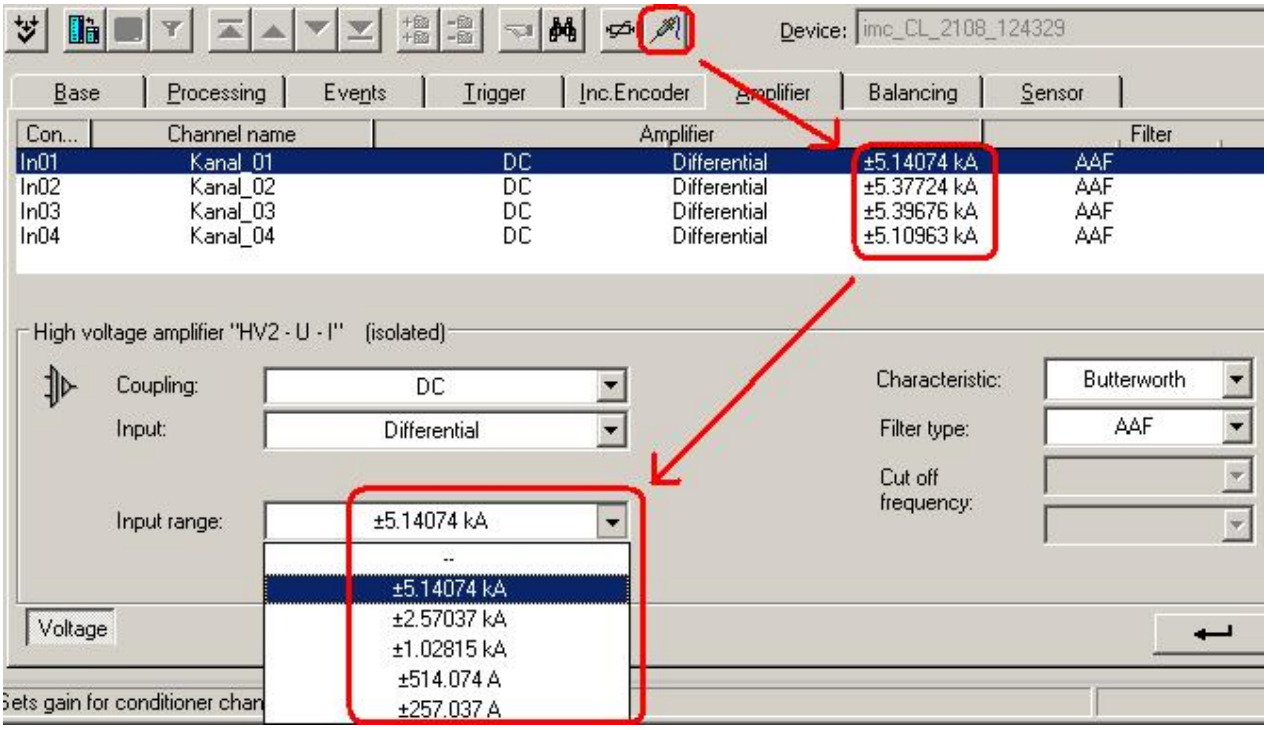
3.5.2.3 Notes on making settings in the imc operating software

Electrically, a current transducer (Current Probe or Rogowski Coil) always measures a voltage. The measurement device converts the captured voltage value to the corresponding current value by means of the Y-factor and unit supplied.

The current transducers provided by imc have been tested and supplied with TEDS which record the associated correction values. These correction values must absolutely be imported in order for the appropriate correction value and unit to be entered along with the experiment.

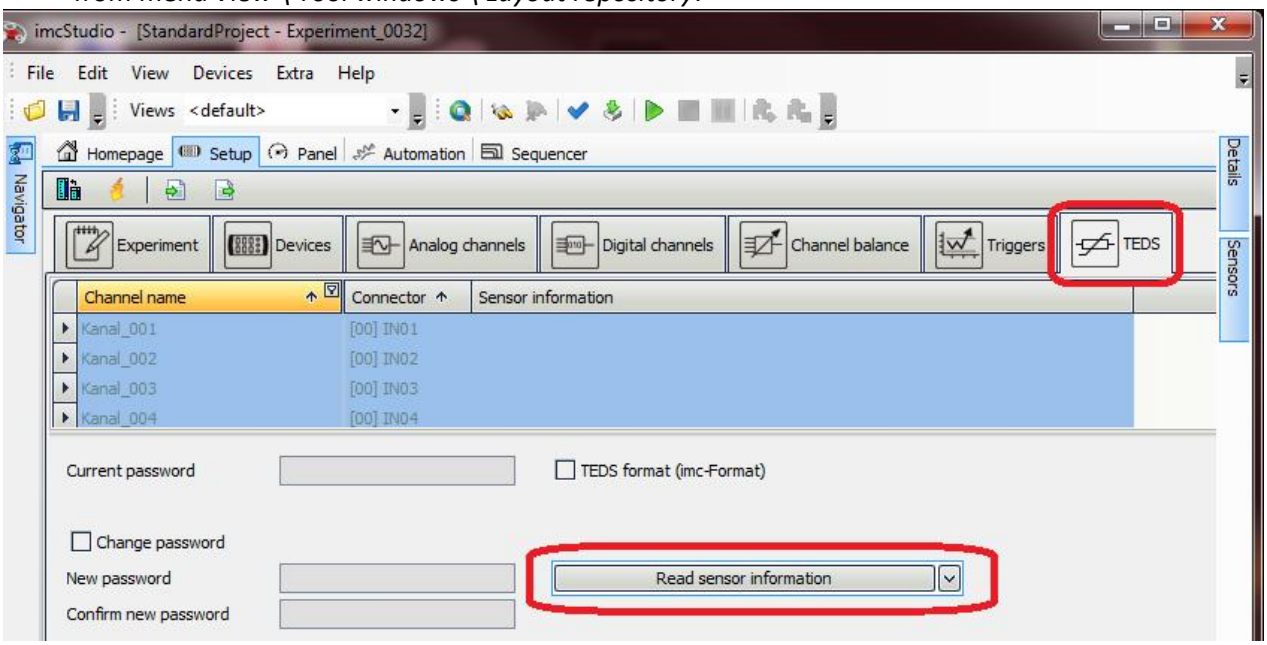
1. Connect the current transducer.
2. Start the imc operating software and connect the device with the PC.
3. Open the configuration dialog under *Settings / Configuration*
4. On the Base page of the dialog, select the current transducer connected
5. Import the transducer's sensor information from the transducer:

   a) With **imc DEVICES** by clicking on the button:



imc DEVICES: Reading the TEDS information calculates the correction values into the measurement ranges

b) With **imc STUDIO** click to *Read sensor information* at the TEDS page. The TEDS page can be loaded from menu *View* \ *Tool windows* \ *Layout repository*.



Reading the TEDS information in imc STUDIO

Note

Note the following:
- The correction values of the individual sensors result in uneven input ranges.
- The available current input ranges result via the scaling factor of the transducer and the amplifiers' voltage measurement ranges (250 mV to 5 V). Only select the ranges, that are appropriate for your Current Transducer. There is no danger for the device with other ranges.
- The displayed input ranges take RMS values into account of up to a crest factor of 1.45. For instance, for a clamp probe of 2000 A RMS-value, an input range of at least 2000 A to 2500 A must be set for the purpose of full utilization.

3.5.2.4 Voltage measurement

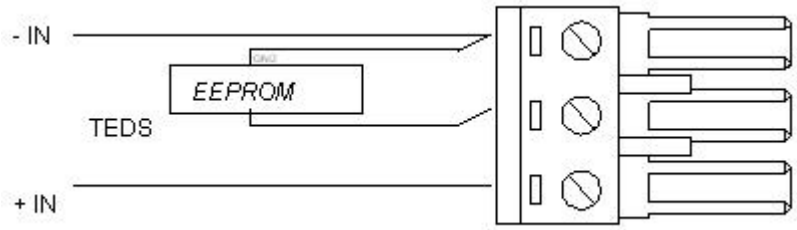
- Voltage: ±5 V to ±250 mV in 4 different ranges

The non-isolated differential inputs are DC-coupled and have a permanent input impedance of 2 MΩ.

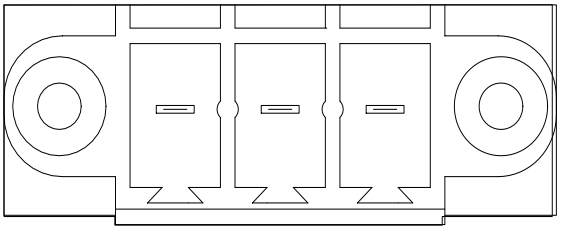
Besides measurement with Current Probes, any other voltage signals can also be connected.

3.5.3 Pin configuration and cable wiring

Cable connection plug – Current measurement channels



Cable connection plug

Plug (female) in device	Signal	Definition
+ IN TEDS - IN 	+IN	Signal input
	-IN	Signal input / Reference potential L or (PE)N
	TEDS	Transducer Electronic Data Sheet Enables recognition of the current probe connected

Warning

ATTENTION!
In order to protect against touch-dangerous voltage the connector housing is always to be used!

3.5.3.1 Notes on the measurement setup

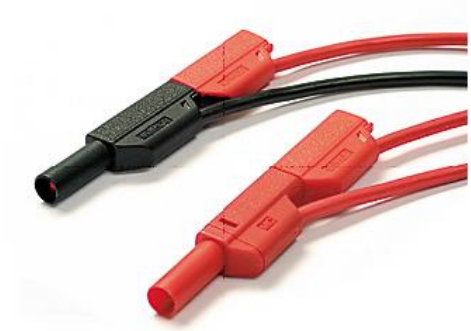
Measurement lines must be kept away from unshielded conductors, sharp edges, electromagnetic fields and other adverse environmental factors.

- Measurement line for the voltage: The measurement line's connection to the measurement object must be designed for the maximum occurring voltage. Before conducting the measurement, check the line leading to it in order to prevent the occurrence of dangerous touch voltages and short circuits. The use of flexible terminals makes special care necessary. It must be checked whether the mechanical connection is secure and what would happen if it is accidentally disconnected. For increased reliability, the lines should be secured at the measurement location. The fuse's breaking capacity must correspond to the expected error current at the measurement location.
- Measurement line for the current: The current probes must be connected in a mechanically secure manner. The aim should be to orient it orthogonally to the current rail or lead. This applies especially to current measurement coils operating according to the Rogowski principle.
- Measurement device: The device must be placed in such a way that no terminals can be accidentally disconnected.

3.5.4 Connection

3.5.4.1 Voltages

For voltage measurements of up to 1000 V (peak), safety banana jacks are provided

The maximum permitted voltage to ground depends on the measurement site, please consider the data sheet **Only use connectors which are protected on all sides against touch.**	

All the inputs are individually isolated.

The voltage channels are each equipped with isolated amplifiers. They enable direct measurement of voltages up to ±1000 V

The measurement signal is connected directly to the device via a safety banana jack.

The analog bandwidth (without low-pass filtering) enables correct measurement of up to the 50 harmonic. The inputs are DC-coupled and have a permanent input impedance in the MW range. The differential response is achieved by means of the isolated configuration.

Note

To the extent possible, use symmetric connection cables having separate leads for both the measurement and reference voltages of each line. Connect the leads for the reference voltage, if necessary, only at the measurement object.

3.5.4.2 Currents

Current measurement is achieved contact-freeCC by means of current probes. To connect these transducers, three-pin screw terminal block are provided.

Current probe MN71

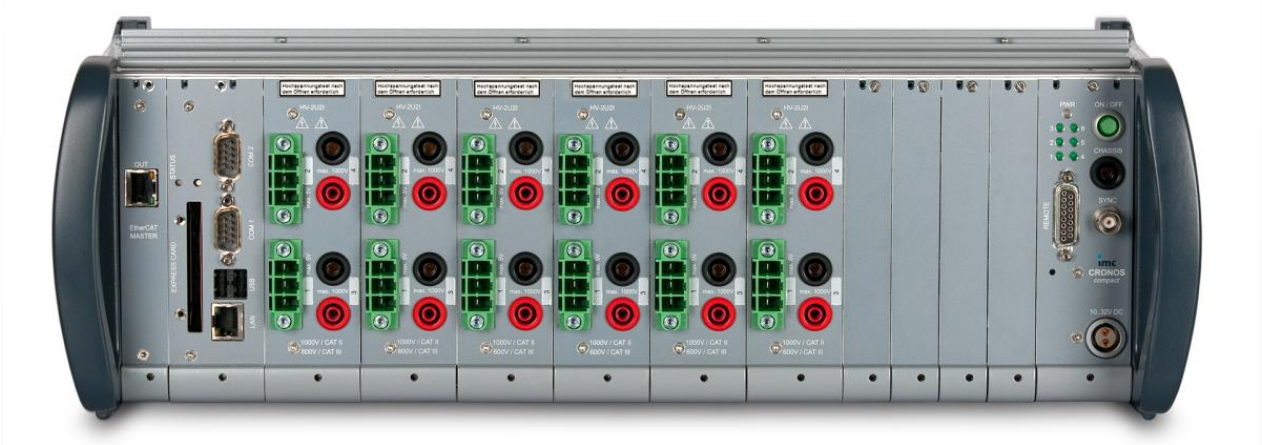
Current transducer AmpFLEX A100

The current probes recommended by imc cover the range for low currents (<10 A) and for medium to high currents (5 kA to 10 kA). With probes having multiple input ranges, the input range set on the probe must also be correctly set by hand in the user's interface.

3.5.4.3 General

Warning

Do not damage the safety seal!
Each high-voltage module of your CL-2108 unit was inspected for compliance with the safety guidelines per DIN EN 61010-1 prior to delivery, and subjected to a high-voltage test. The module is sealed after having passed these final tests.
If the safety seal is damaged, safe work cannot be ensured.
Any intervention, for instance temporary removal of the module, makes re-inspection for safety.



imc CRONOS*compact* equipped with CRC/HV-2U2I
current channels 86: ch01 + ch02 (three-pin screw terminal block)
voltage channels 85: ch03 + ch04 (banana)

3.5.5 Bandwidth

The channels' max. sampling rate is 100 kSamples/s (10 µs sampling interval). The analog bandwidth (without digital low-pass filtering) is 14 kHz (-3 dB).

3.6 CS-3008-1 [-N], CL-3016-1 [-N], CL-3024-1 [-N]

CS-3008-1 [-N], CL-3016-1 [-N] and CL-3024-1 [-N] are 8-, 16- and 24-channel compact measurement devices, that include an **internal** IEPE/ICP expansion respectively, with sampling rates of up to 100 kHz per channel. The BNC inputs provide supply for current feed sensors.

The C-30xx-1 [-N] supports TEDS 29 (Transducer Electronic Data Sheet) as per IEEE 1451.4 Class I Mixed Mode Interface. According to this protocol, both TEDS data and analog signals are sent and received along the same line.

The C-30xx-1 [-N]is an advanced development of C-30xx. Unless any limitations are mentioned, the following description also applies to the C-30xx-1 [-N].

Technical data sheet 147

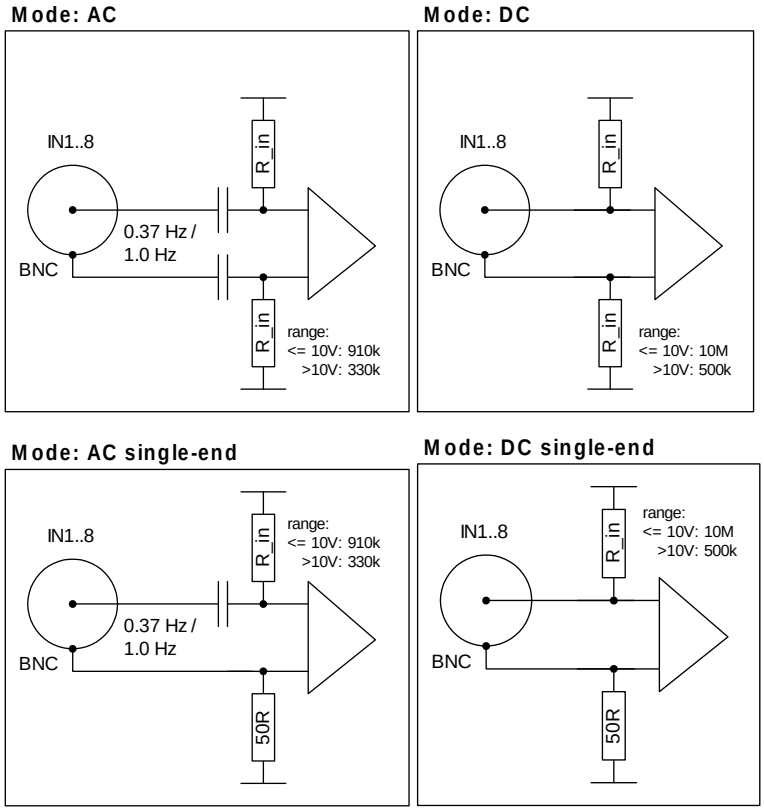
3.6.1 Voltage measurement

- Voltage: ±50 V to ±5 mV

In the voltage ranges ±50 V and ±20 V, a voltage divider is in operation; the resulting input impedance is 1 MΩ in DC mode and 0.67 MΩ in AC mode. In the voltage ranges ≤±10 V, by contrast, the input impedance is 20 MΩ in DC and 1.82 MΩ in AC mode. When the device is deactivated, it drops to about 1 MΩ.

With the AC coupled ICP-measurement the DC voltage is suppressed by a high pass filter of 0.37 Hz for all ranges ≤±10 V. For the ranges ≥±20 V the low pass cut-off frequency is 1 Hz. The input configuration is differential.

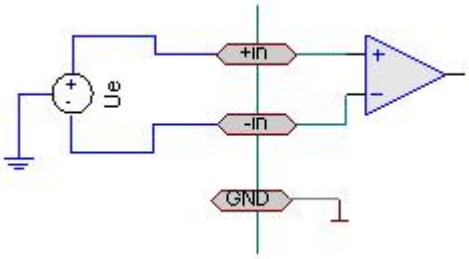
3.6.1.1 Input coupling



Note

In the settings mode *Sensor with current feed*, an open-circuit current-fed voltage of about 30 V is present at the BNC sockets, which can cause damage to other (non-current-fed) sensor types. For that reason, this mode should only be set for appropriate sensors.
It is assured that no current feed is active when the device is started. This state remains in effect until the measurement is first prepared, no matter what is set in the user's interface.

3.6.1.2 Case 1: Voltage source with ground reference



The voltage source itself already is referenced to the device's ground. The voltage source is at the same potential as the device ground.

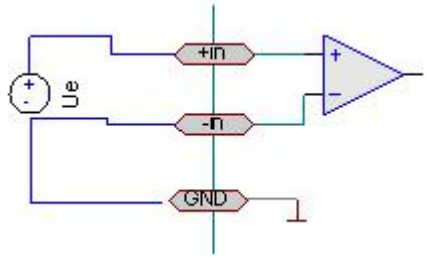
Example

The measurement system is grounded. Thus, the input GND is at ground potential. If the voltage source itself is also grounded, it is referenced to the device ground. It isn't any problem if, as it may be, the ground potential at the voltage source deviates from the ground potential of the device itself by a few degrees. The maximum permitted common mode voltage must not be exceeded.

Note

In this case, the negative signal input -IN may not be connected to the ground contact GND in the device. Otherwise, a ground loop would result, through which interference could be coupled in.
In this case, a true differential (but not isolated!) measurement is performed.

3.6.1.3 Case 2: Voltage source without ground reference



The voltage source itself has no reference to the device's ground, but instead, its potential floats freely compared to the device ground. If a ground reference cannot be established, it's also possible to connect the negative signal input –IN to the ground contact GND.

Example

A voltage source which isn't grounded (e.g. a battery) and whose contacts have no connection to ground potential is measured. The measurement system is grounded.

Note

When –IN and GND are connected, be sure that the signal source's potential can actually be drawn to the device ground's potential without an appreciable current flowing. If the source can't be brought to that potential level (because it turns out to be at fixed potential after all), there is a risk of permanent damage to the amplifier. If IN and GND are connected, a single end measurement is performed. This isn't a problem unless a ground reference already existed.

3.6.2 Bandwidth

The channels' **max. sampling rate** is 100 kSamples/s (10 µs sampling interval). The **analog bandwidth** (without digital low-pass filtering) is 14 kHz and with C-30xx-1 [-N]: 48 kHz (-3 dB). In AC mode the lower cut off frequency is 0.37 Hz for all ranges ≤±10 V, else 1 Hz.

3.6.3 Connection

The interconnections are of the type BNC.

3.7 CS-4108 [-N], CL-4124 [-N]

CS-4108 [-N] and CL-4124 [-N] are 8- and 24-channel universal measurement devices, respectively, with sampling rates of up to 50 kHz per channel. They are specially designed for measurement tasks in environments with unclear voltage fields such as test rigs or large-scale machinery. The input channels are electrically isolated, differential and equipped with per-channel signal conditioning including filters.

The isolated voltage channels of the CS-4108 [-N] and CL-4124 [-N] devices have their **own isolated amplifier**, operated in the voltage mode.

Along with voltage measurement, current measurement via a shunt plug and temperature measurement via temperature plug ACC/DSUB-T4 can be performed. The use of the ICP-extension plug 68 is also possible, however it **cancels the insulation**. The channels support TEDS (Transducer Electronic Data Sheet as per IEEE 1451.4)

The technical data of the CS-4108, CL-4124 149.

General remarks on isolated channels

When using an isolated channel (with or without supply), one should make sure the common mode potential is "defined", one way or another: Using an isolated channel on an isolated signal source usually does not make sense. The very high common mode input impedance of this isolated configuration (>1 GΩ) will easily pick up enormous common mode noise as well as possibly letting the common mode potential drift to high DC-level. These high levels of common-mode noise will not be completely rejected by the amplifier's common-mode (isolation-mode) rejection.

So, as a general rule: isolated amps should be used in environments where the common-mode level is high but "well defined" in terms of a low (DC-) impedance towards (non-isolated) system ground (CHASSIS).

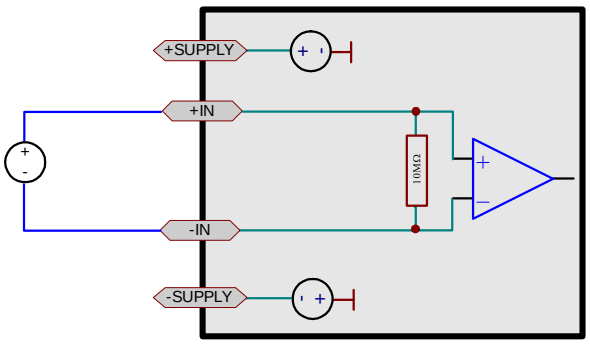
If, in turn, the signal source itself is isolated, it can be forced to a common-mode potential, which is the potential of the measurement equipment. This is the case with a microphone: the non-isolated power supply will force the common mode potential of the microphone and amp-input to system ground instead of leaving it floating, which would make it susceptible to all kinds of noise and disturbance.

3.7.1 Voltage measurement

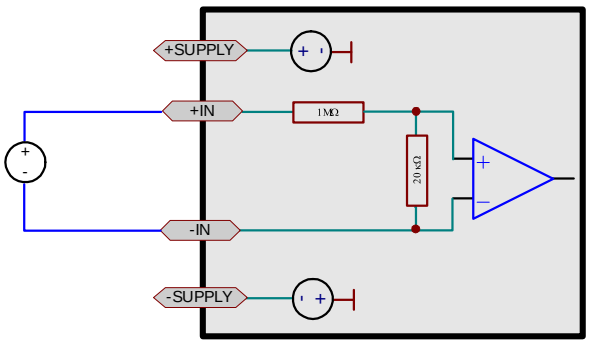
- Voltage: ±60 V to ±5 V with divider
- Voltage: ±2 V to ±50 mV without divider

An **internal pre-divider** is in effect in the voltage ranges ±60 V to ±5 V. In this case, the differential input impedance is 1 MΩ, in all other ranges 10 MΩ. If the device is de-activated, the impedance is always 1 MΩ.

The inputs are DC-coupled. The differential response is achieved by means of the isolated circuiting.



configuration for voltages <5 V



configuration for voltages >2 V with internal divider

3.7.2 Temperature measurement

The input channels are designed for measurement with **thermocouples and Pt100**-sensors (RTD, platinum resistance thermometers as per DIN and IEC 751). Any combinations of the two sensor types can be connected.A detailed description of temperature measurement is presented here 30.

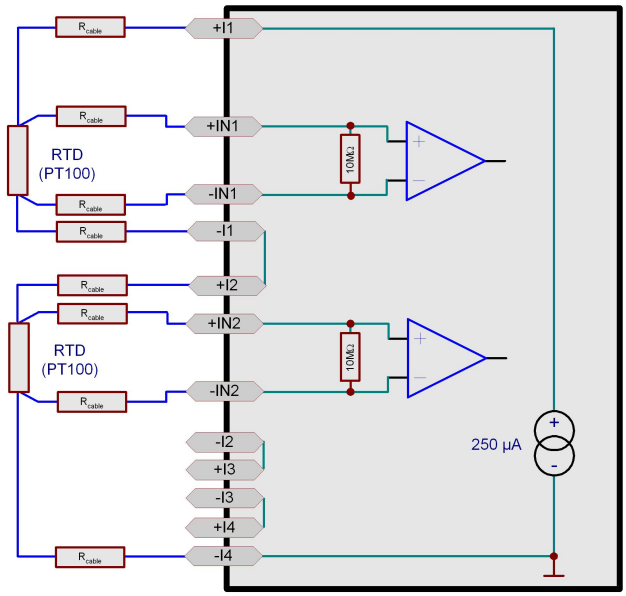
Temperature measurement is performed with the imc connector ACC/DSUB-T4 32. Thermocouples can alternatively be captured using two-pin thermo-connectors.

3.7.2.1 Thermocouple measurement

The common thermocouple types make use of linearization by characteristic curve.

The cold-junction compensation necessary for thermocouple measurements is built into the imc thermo-connector (ACC/DSUB(M)-T4 32).

3.7.2.2 Pt100 (RTD) - Measurement



Along with thermocouples, **Pt100** sensors can also be connected, in **4-wire configuration**. An extra reference current source feeds an entire chain of up to four serially connected sensors.

The imc-thermo plugs(ACC/DSUB-T4) has 4 contacts which are available for the purpose of 4-wire measurements. These current-supply contacts are internally wired so that the reference current loop is automatically closed when all four Pt100 units are connected. This means that the –I contact of one channel is connected to the +I contact of the next channel (see the sketch imc thermoplug 32). Therefore, for channels not connected to a Pt100 sensor, a wire jumper must be used to connect the respective "+Ix" and "-Ix" contacts.

Normal DSUB-15 connectors don't come with these extra "auxiliary contacts" for 4-wire connections. This means that you must take steps to ensure that the reference current flows through all Pt100 units. Only "+I1" (DSUB(9), Terminal K1, "(RES.)") and "–I4" (DSUB(6), Terminal K10, "(GND)") are available as a contact or DSUB-15 pin, respectively. The connections "–I1 = +I2", "–I2 = +I3", and "–I3 = +I4" must be wired externally.

Pt100 sensors are fed from the module and don't have or even require an arbitrarily adjustable reference voltage in the sense of an externally imposed common mode voltage. It is also not permissible to set one up, for instance by grounding one of the four connection cables: the Pt100 reference current source is referenced to the device's frame (CHASSIS), and is thus not isolated.

3.7.3 Current fed sensors

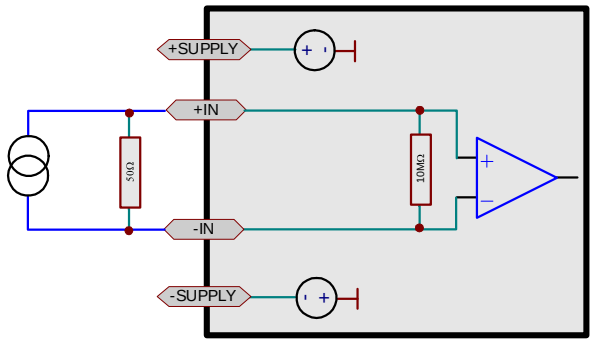
At the connection sockets, a permanent 5 V supply voltage for external sensors 73 or for the ICP expansion plugs ACC/DSUB-ICP 68 and ACC/DSUB-ICP2-BNC 71 is available. This voltage source is grounded to the measurement device's frame.

The description of measurement with ICP sensors is presented here. 68

3.7.4 Current measurement

- Current: ±40 mA, ±20 mA, ±10 mA ... ±1 mA in 6 ranges

A special plug (order-code: ACC/DSUB-I4) with a built-in **shunt** (50 Ω) is needed for current measurement.

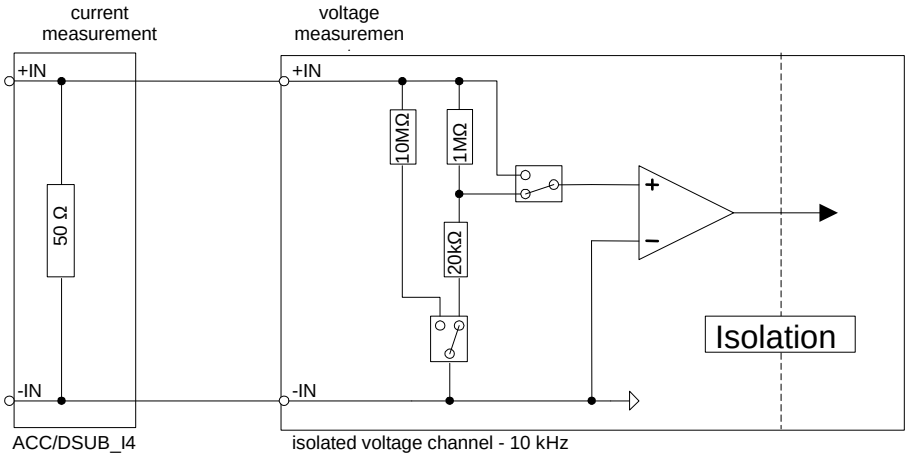


For current measurement with the special shunt-plugs *ACC/DSUB-I4*, inputs ranging only up to **max. ±50 mA** (corresponding to 2 V or 2.5 V voltage ranges) are permitted due to the measurement shunt's limited power dissipation in the case of static long-term loading.

Note

Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc DEVICES interface.
The scaling factor is entered as 1/R and the unit as A (e.g. 0.02 A/V = 1/50 Ω).

Input stage block schematic



3.7.4.1 Current measurement with internal shunt

3.7.5 Bandwidth

The channels' **max. sampling rate** is 100 kHz (10 µs). The **analog bandwidth** (without digital low-pass filtering) is 11 kHz (-3 dB).

3.7.6 Connection

For **signal connections**, **DSUB-15** connectors can be used.

Pin configuration of the DSUB-15 189.

3.8 CS-5008-1 [-N], CL-5016-1 [-N], CX-5032-1 [-N]

The inputs of the C-50xx devices are for voltage, current and bridge signals. They share a common voltage supply for sensors and measurement bridges.

All signal inputs are ***differential***, ***not isolated*** and support TEDS.

Parameter	typ.	min. / max.	Remarks
Measurement modes DSUB	bridge-sensor bridge: strain gauge voltage current charge current feed sensors (IEPE/ICP)		ACC/DSUB(M)-UNI2 (for all modes) ACC/DSUB(M)-I2 shunt-plug or single ended (internal shunt) ACC/DSUB-Q2 ACC/DSUB-ICP2 (ICP™-, Deltatron®-, Piezotron®-Sensors)

The amplifier used in the devices C-50xx-1 [-N] is a successor model of the amplifier in the C-50xx devices. Unless any limitations are mentioned, the following description also applies to the C-50xx devices.

The technical data of the 153 *CS-5008-1 [-N], CL-5016-1 [-N], CX-5032-1 [-N]* 153.

3.8.1 Bridge measurement

Measurement of **measurement bridges** such as strain gauges.

The measurement channels have an adjustable DC voltage source which supplies the measurement bridges. The supply voltage for a group of eight inputs is set in common. The bridge supply is asymmetric, e.g., for a bridge voltage setting of *VB=5 V*, Pin *+VB (C)* is at *+VB=5 V* and Pin *-VB (D)* at *-VB=0 V*. The terminal *–VB* is simultaneously the device's ground reference.

Per default 5 V and 10 V can be selected as bridge supply. As an option the amplifier can be build with 2.5 V bridge supply. Depending on the supply set, the following input ranges are available:

Bridge voltage [V]	Measurement range [mV/V]
10	±1000 to ±0.5
5	±1000 to ±1
2.5 (optional)	±1000 to ±2

Fundamentally, the following holds: For equal physical modulation of the sensor, the higher the selected bridge supply is, the higher are the absolute voltage signals the sensor emits and thus the measurement's **signal-to-noise ratio** and drift quality. The limits for this are set by the maximum available current from the source and by the dissipation in the sensor (temperature drift!) and in the device (power consumption!)

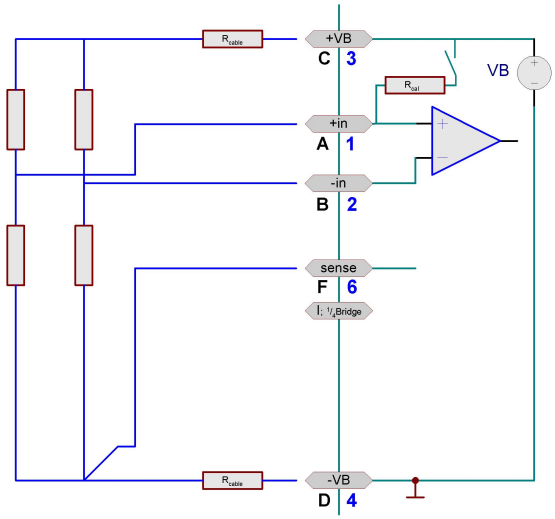
- For typical measurements with **strain gauges**, the ranges 5 mV/V to 0,5 mV/V are particularly relevant.
- There is a maximum voltage which the **potentiometer sensors** are able to return, in other words max. 1 V/V; a typical range is then 1000 mV/V.

Bridge measurement is set by selecting as measurement mode either *Bridge: Sensor* or *Bridge: Strain gauge* in the operating software. The bridge circuit itself is then specified under the tab Bridge circuit, where *quarter bridge, half bridge* and *full bridge* are the available choices.

Note

We recommend to angle a maximum range on the not used voltage measurement. An open entry in half- or quarter bridge mode can annoy the neighbor channels if this is also in half- or quarter bridge mode.

3.8.1.1 Full bridge



A full bridge has four resistors, which can be four correspondingly configured strain gauges or one complete sensor which is a full sensor internally.

The full bridge has five terminals to connect. Two leads *+VB(C)* and *-VB(D)* serve supply purposes, two other leads *+in (A)* and *-in(B)* capture the differential voltage. The fifth lead *sense(F)* is the Sense lead for the lower supply terminal, which is used to determine the single-sided voltage drop along the supply line.

Assuming that the other supply cable *+VB(C)* has the same impedance and thus produces the same voltage drop, no 6th lead is needed. The Sense lead makes it possible to infer the measurement bridge's true supply voltage, in order to obtain a very exact measurement value in mV/V.

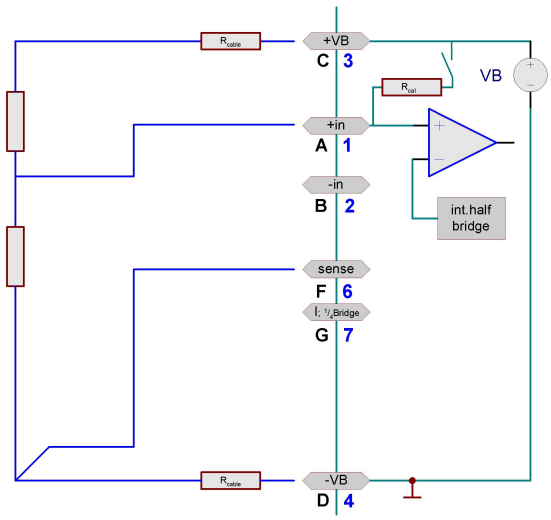
Please note that the maximum allowed voltage drop along a cable may not exceed approx. 0.5 V. This determines the maximum possible cable length.

If the cable is so short and its cross section so large that the voltage drop along the supply lead is negligible. In this case the bridge can be connected at four terminals by omitting the Sense line.

Note

For the predecessor model C-50xx pin sense(F) must never be unconnected! In that case, sense(F) and -VB (D) must be jumpered.

3.8.1.2 Half bridge



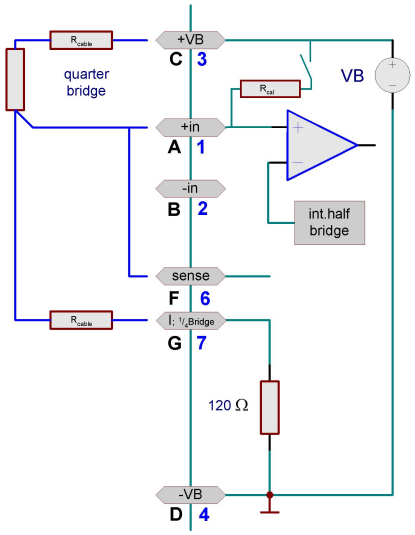
A half bridge may consist of two strain gauges in a circuit or a sensor internally configured as a half bridge, or a potentiometer sensor. The half bridge has 4 terminals to connect. For information on the effect and use of the Sense lead *sense (F)*, see the description of the full bridge.

The amplifier internally completes the full bridge itself, so that the differential amplifier is working with a genuine full bridge 103.

Note

It is important that the measurement signal of the half bridge is connected to *+IN (A).* The *IN (B)* access leads to implausible measured values and influences the neighbor channels.

3.8.1.3 Quarter bridge



A quarter bridge can consist of a single strain gauge resistor, whose nominal value can be 120 Ω or 350 Ω.

The amplifier internally completes an additional 120 Ω or 350 Ω quarter bridge switchable by software.

The quarter bridge has 3 terminals to connect. Refer to the description of the full bridge for comments on the Sense lead. However, with the quarter bridge, the Sense lead is connected to *+in(A)* and *sense(F)* jointly.

If the sensor supply is equipped with the option "±15 V", a quarter bridge measurement is not possible. The pin *I_1/4B* for the quarter bridge completion is used for–15 V instead.

Note

In the predecessor model C-50xx there is an internal 120 Ω completion resistor for bridge measurement. A 350 Ω completion resistor for quarter bridge measurement is possible as an alternative. When using this option, the scope of available function is limited:

- No direct current measurement is possible with the included default connector ACC/DSUB-UNI2, but it is possible only with the optional connector ACC/DSUB-I2 with a 50 Ω shunt resistor (differential measurement).

3.8.1.4 Sense and initial unbalance

The SENSE lead serves to compensate voltage drops due to cable resistance, which would otherwise produce noticeable measurement errors. If there are no sense lines, then *SENSE (F)* must be connected in the terminal plug according to the sketches above.

Bridge measurements are relative measurements (**ratiometric procedure**) in which the fraction of the bridge supply fed in which the bridge puts out is analyzed (typically in the 0.1% range, corresponding to 1 mV/V). Calibration of the system in this case pertains to this ratio, the bridge input range, and takes into account the momentary magnitude of the supply. This means that the **bridge supply's actual magnitude is not relevant** and need not necessarily lie within the measurement's specified overall accuracy.

Any **initial unbalance** of the measurement bridge, for instance due to mechanical pre-stressing of the strain gauge in its rest state, must be zero-balanced. Such an unbalance can be many times the input range (bridge balancing). If the initial unbalance is too large to be compensated by the device, a larger input range must be set.

Possible initial unbalance

input range [mV/V]	bridge balancing (VB = 5 V) [mV/V]	bridge balancing (VB = 10 V) [mV/V]
±1000	500	150
±500	100	250
±200	100	50
±100	15	50
±50	15	7
±20	3	7
±10	10	15
±5	10	5
±2	3	5
±1	4	5
±0.5	-	-

3.8.1.5 Balancing and shunt calibration

The amplifier offers a variety of possibilities to trigger bridge balancing:

- Balancing / shunt calibration upon activation (cold start) of the unit. If this option is selected, all the bridge channels are balanced as soon as the device is turned on.
- Balancing / shunt calibration via the on the *Amplifier balance tab*.
- In shunt calibration, the bridge is unbalanced by means of a 59.8 kΩ or 174.66 kΩ shunt. The results are:

Bridge resistance	120 Ω	350 Ω
59.8 kΩ 174.7 kΩ	0.5008 mV/V 0.171 mV/V	1.458 mV/V 0.5005 mV/V

The procedures for balancing bridge channels also apply analogously to the voltage measurement mode with zero-balancing.

Hinweis

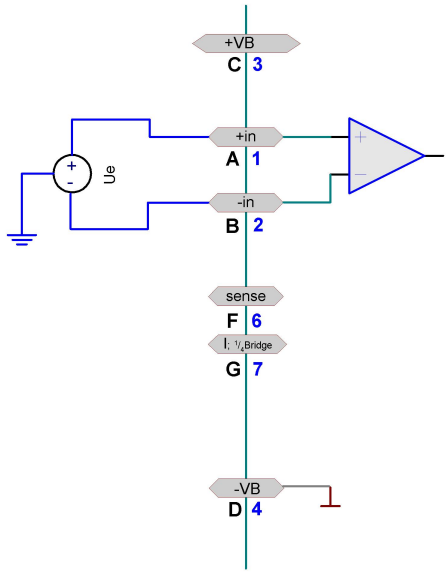
- We recommend setting channels which are not connected for voltage measurement at the highest input range. Otherwise, if unconnected channels are in quarter- or half-bridge mode, interference may occur in a shunt calibration!

3.8.2 Voltage measurement

- Voltage: ±10 V to ±5 mV in 9 different ranges

The input impedance is 20 MΩ. (1 MΩ when switched off)

3.8.2.1 Voltage source with ground reference



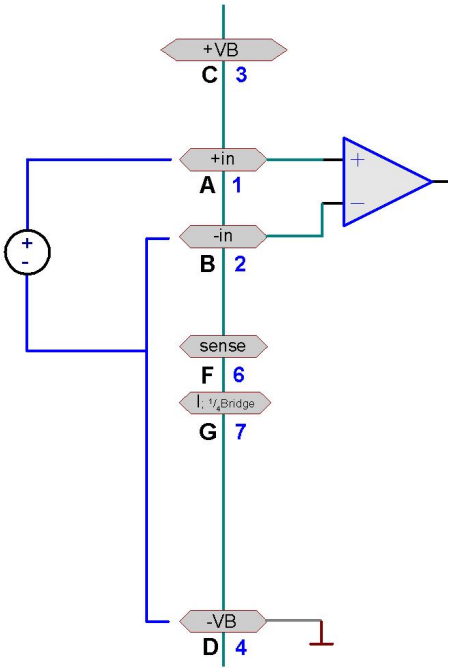
The voltage source itself already has a connection to the device's ground. The potential difference between the voltage source and the device ground must be fixed.

Example: The device is grounded. Thus, the input -VB (D) is also at ground potential. If the voltage source itself is also grounded, it's referenced to the device ground. It doesn't matter if the ground potential at the voltage source is slightly different from that of the device itself. But the maximum allowed common mode voltage must not be exceeded.

Important: In this case, the negative signal input -in (B) may not be connected with the device ground -VB (D). Connecting them would cause a ground loop through which interference could be coupled in.

In this case, a genuine differential (but not isolated!) measurement is carried out.

3.8.2.2 Voltage source without ground reference

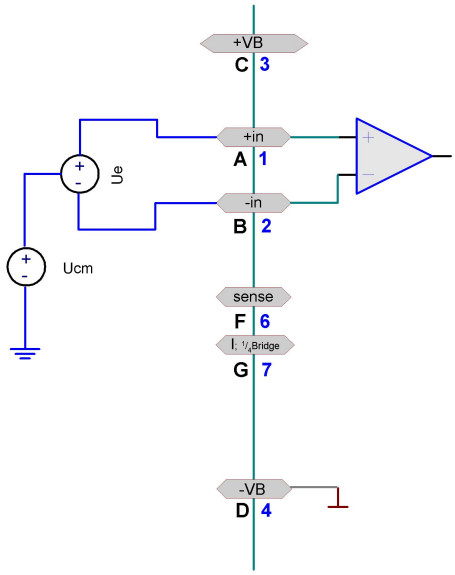


The voltage source itself is not referenced to the device ground but is instead isolated from it. In this case, a ground reference must be established. One way to do this is to ground the voltage source itself. Then it is possible to proceed as for "Voltage source with ground reference". Here, too, the measurement is differential. It is also possible to make a connection between the negative signal input and the device ground, in other words to connect -in(B) and -VB(D).

Example: An ungrounded voltage source is measured, for instance a battery whose contacts have no connection to ground. The module is grounded.

Important: If -in(B) and -VB(D) are connected, care must be taken that the potential difference between the signal source and the device doesn't cause a significant compensation current. If the source's potential can't be adjusted (because it has a fixed, overlooked reference), there is a danger of damaging or destroying the amplifier. If -in(B) and D are connected, then in practice a single-ended measurement is performed. This is no problem if there was no ground reference beforehand.

3.8.2.3 Voltage source at a different fixed potential



The common mode voltage (U_{cm}) has to be less than ±10 V. It is reduced by ½ input voltage.

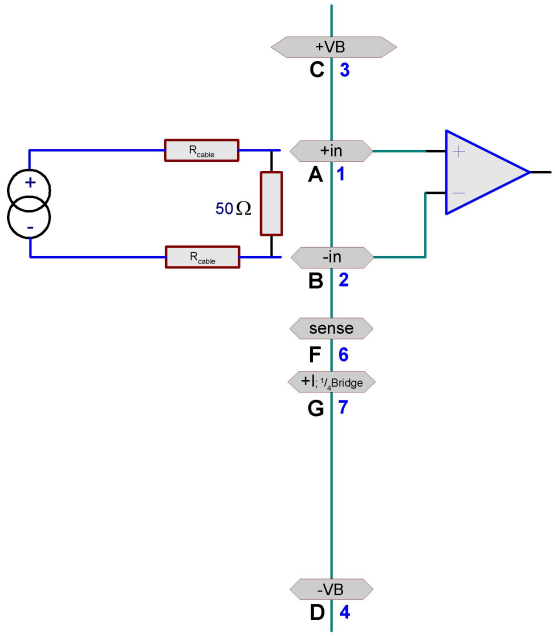
Example: Suppose a voltage source is to be measured which is at a potential of 120 V to ground. The device itself is grounded. Since the common mode voltage is greater than permitted, measurement is not possible. Also, the input voltage difference to the device ground would be above the upper limit allowed. For such a task, the C-50xx cannot be used!

3.8.3 Current measurement

Current is measured via the imc connector ACC/DSUB-I2 or with ground reference via the internal quarter bridge completion.

3.8.3.1 Differential current measurement

Current ±50 mA to ±1 mA



For current measurement could be used the DSUB plug ACC/DSUB-I2. That connector comes with a 50 Ω shunt and is not included with the standard package. It is also possible to measure a voltage via an externally connected shunt. Appropriate scaling must be set in the user interface. The value 50 Ω is just a suggestion. The resistor needs an adequate level of precision. Pay attention to the shunt's power consumption.

The **maximum common mode voltage** must be in the range ±10 V for this circuit, too. This can generally only be ensured if the current source itself already is referenced to ground. If the current source is ungrounded a danger exists of exceeding the maximum allowed overvoltage for the amplifier. The current source may need to be referenced to the ground, for example by being grounded.

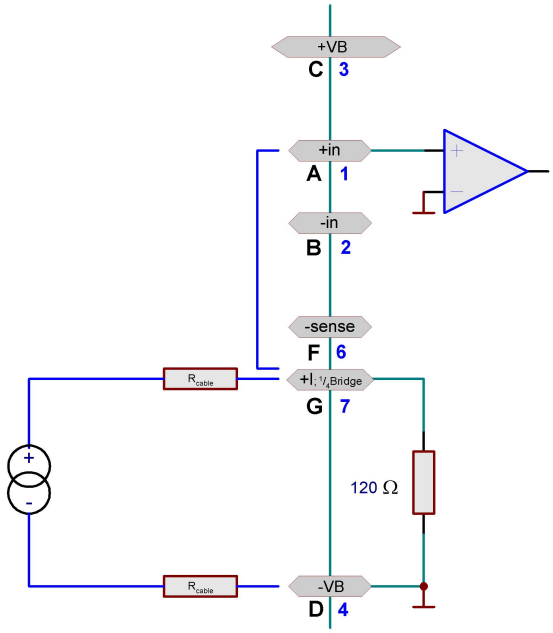
The sensor can also be supplied with a software-specified voltage via Pins *+VB(C)* and *-VB(D)*.

Note

Since in this procedure a voltage measurement at the shunt resistor is involved, it is necessary that imcDevices also be set for voltage measurement. The scaling factor is entered as 1/R and the unit set is A (0.02 A/V = 1/50 Ω).

3.8.3.2 Ground-referenced current measurement

- Current: ±50 mA to ±2 mA



In this circuit, the current to be measured flows through the 120 Ω shunt in the amplifier. Note that here, the terminal *-VB(D)* is simultaneously the device's ground. Thus, the measurement carried out is single-end or ground referenced. The potential of the current source itself may be brought into line with that of the units ground. In that case, be sure that the device unit itself is grounded.

In the settings interface, set the measurement mode to Current.

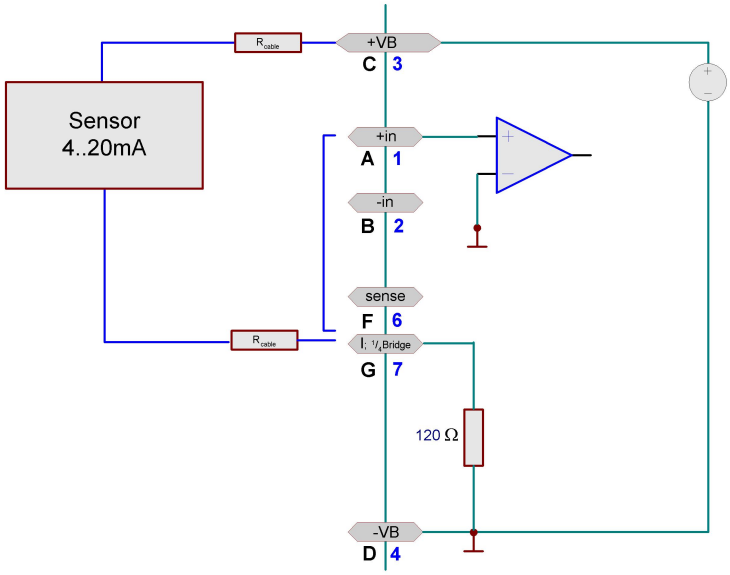
Note that the jumper between *+IN(A)* and *+I; ¼Bridge(G)* should be connected right inside the connector.

Note

- For an (optional) sensor supply with ±15 V ground referenced current measurement is not possible. The pin *I;¼Bridge* is used as –15 V pin.
- For the former Cx-50 equipped with a 350 Ω quarter bridge completion, ground referenced current measurement is not possible!

3.8.3.3 2-wire for sensors with a current signal and variable supply

- E.g. for pressure transducers 4 mA to 20 mA



Transducers which translate the physical measurement quantity into their own current consumption and which allow variable supply voltages can be configured in a two-wire circuit. In this case, the device has its own power supply and measures the current signal.

In the settings dialog on the index card *Universal amplifiers/ General*, a supply voltage is set for the sensors, usually 24 V. The channels must be configured for *Current measurement*.

The sensor is supplied with power via Terminals *+VB(C)* and *+I; ¼Bridge(G)*.

The signal is measured by the amplifier between *+in(A)* and *I; ¼Bridge(D)*. For this reason, a wire jumper must be positioned between Pins *+in(A)* and *I; ¼Bridge(G)* inside the connector pod.

Hinweis

- There is a voltage drop across the resistances of the leadwires and the internal measuring resistance of 120 Ω which is proportional to the amperage. This lost voltage is no longer available for the supply of the transducer (2.4 V = 120 Ω * 20 mA). For this reason, you must ensure that the resulting supply voltage is sufficient. It may be necessary to select a leadwire with a large enough cross-section.

3.8.4 Sensors with current feed

Measurement of current-fed sensors, e.g. ICPs is possible with the DSUB-15 imc plugs. Therefore the special connector ACC/DSUB-ICP2 is required.

For measurement of current-fed sensors, the special connector ACC/DSUB-ICP2 is required.

For the description of the measurement with current feed sensors, see here 68.

Note

- The ACC/DSUB-ICP2 plug cannot be used together with triaxials.

3.8.5 Sensor supply

The *C-50xx* channels are enhanced with an integrated sensor supply unit, which provides an adjustable supply voltage for active sensors. The supply outputs are electronically protected internally against short circuiting to ground. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

The supply voltage can only be set for a group of eight channels.

The supply outputs are electronically protected internally against short circuiting to ground. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

The voltage selected is also the supply for the measurement bridges. If a value other than 5 V or 10 V is set, bridge measurement is no longer possible!

3.8.6 Bandwidth

The channels' **maximum sampling rate** is 100 kHz (10 µs). The analog bandwidth (without digital low-pass filtering) is 5 kHz (-3 dB).

3.8.7 Connection

For the signal connections, it is possible to use either **DSUB-15**.

Pin configuration of the DSUB-15 189

3.9 CS-6004-1 [-N], CL-6012-1 [-N]

The CS-6004-1 [-N] and CL-6012-1[-N] measurement devices come with a high-end bridge amplifier for direct connection of strain gauges.

The amplifier can run in either DC- or CF-mode and allows double sensor leads and symmetrical bridge supply.

With these properties and with the especially quiet 24-bit measurement amplifier, this module is ideal for measuring mechanical strains.

Parameter	Value	Remarks
Measurement modes with DSUB	full bridge half bridge quarter bridge	Voltage or bridge mode globally selected for all four channels.
	LVDT	inductive transducers (CF)
	voltage	
	current	with ACC/DSUB(M)-I2
	current-fed sensors IEPE/ICP	ACC/DSUB-ICP2

Highlights:

- DC and Carrier frequency mode (5 kHz)
- Lead wire compensation with single and dual sense line configurations are supported (e.g. 5/6-wire-circuit with full bridge)
- Symmetric bridge supply of 1 V, 2.5 V, 5 V and with DC and CF (AC) mode
- Software selectable quarter bridge completion 120 Ω and 350 Ω switchable

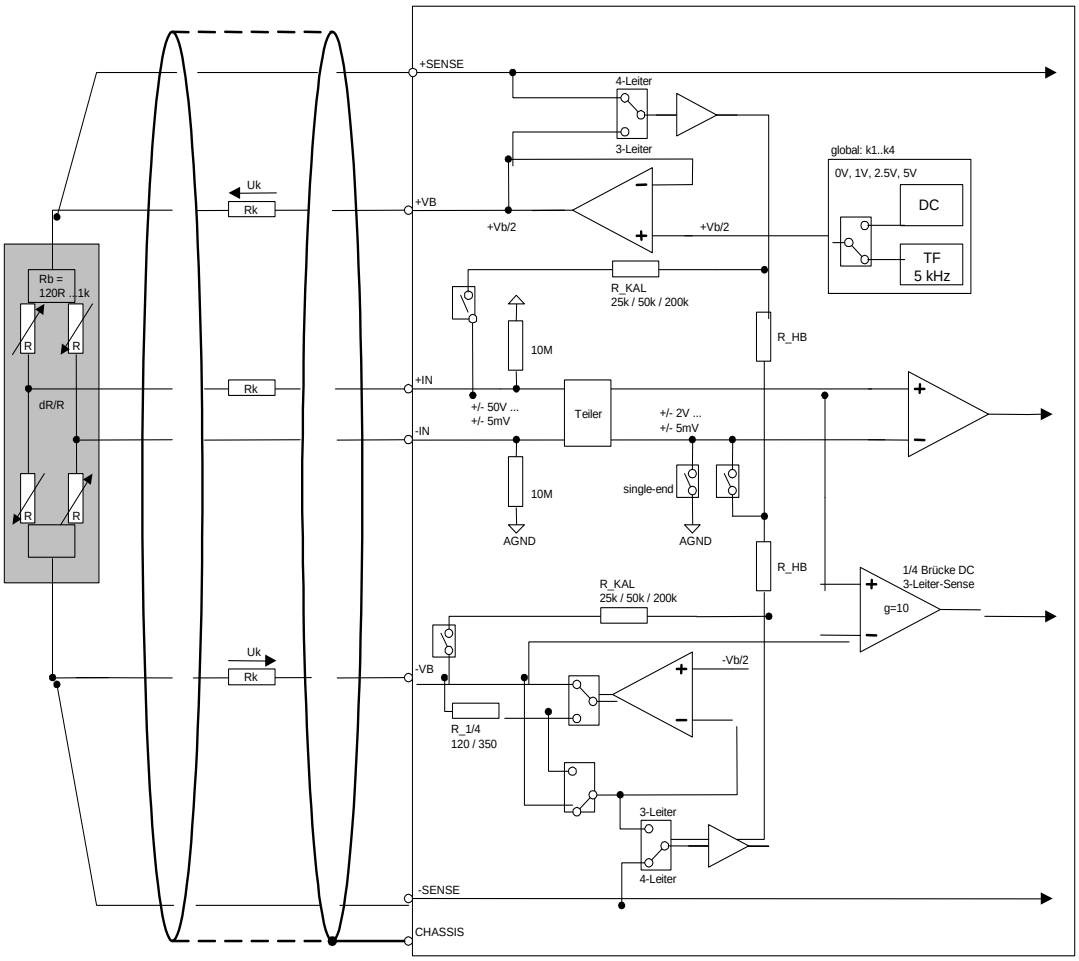
Required software version:

Note

As of imc DEVICES Version 2.7 R3 SP7:
- experiments created with a Cx-60 can be used with a Cx-60-1 [-N]
- ±SENSE will be detected automatically by those devices. The pinning of the ACC/DSUB(M)-B2 is changed in contrary to the former CRPL/DSUB-BR-4-BR and therefore similarly to all bridge modules.

Technical details of the CS-6004-1 [-N], CL-6012-1 [-N] 157.

3.9.1 Bridge measurement



Block schematic

Sense line

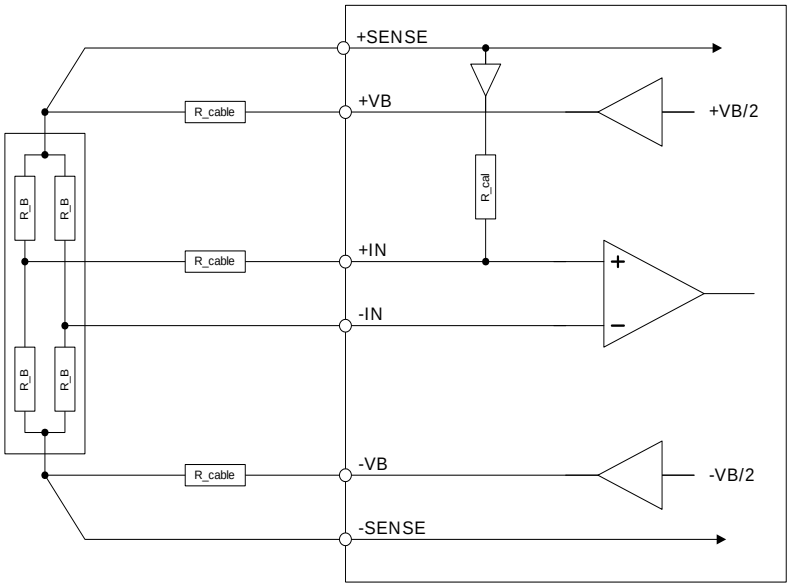
The amplifier supports configurations with single-line sense, for compensation of symmetric cables:

Just leave the unused sense line unconnected (+ or –SENSE): Internal pulldown-resistors provide defined zero levels to detect the SENSE configuration automatically. It will be shown at the balance dialog of imcDevices and allows probe-breakage recognition.

The pin configuration of the imc-plugs 189.

3.9.1.1 Full bridge

Connection scheme: Full bridge, double sense



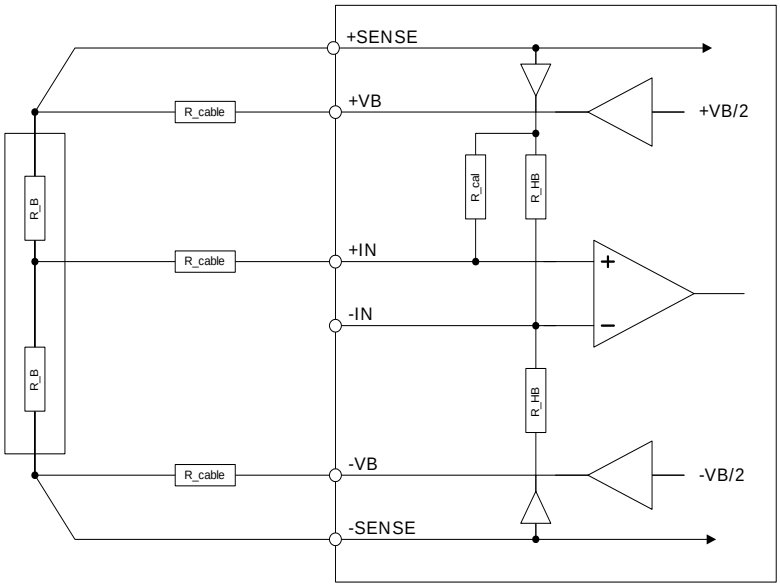
- 6-wire connection
- Both SENSE-lines, ±SENSE, used ("double sense").
  Compensation of the influence even of asymmetric cable resistances.
- Calibration resistor for shunt calibration;
  for long cables in CF mode, reduced precision due to phase errors

Connection scheme: Full bridge, double and single line-Sense

- Analogous to the corresponding half-bridge configuration

3.9.1.2 Half bridge

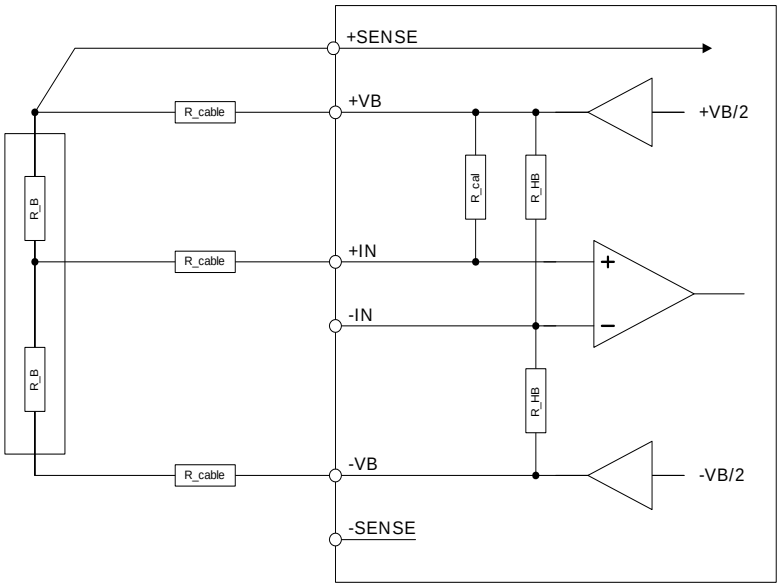
Connection scheme: Half-bridge, double Sense



Half-bridge, double Sense

- 5-wire connection
- Both SENSE-lines, ±SENSE, used (double Sense):
  Compensation of the influence even of asymmetric cable resistances.
- Calibration resistor for shunt calibration: shunt calibration of external half-bridge arm;
  for long cables in CF mode, reduced precision due to phase errors
- Internal half-bridge completion excitation is controlled by an internal, buffered SENSE line;
  therefore asymmetric cable is permitted without the resulting offset-drift!

Connection scheme: Half-bridge, single line-Sense



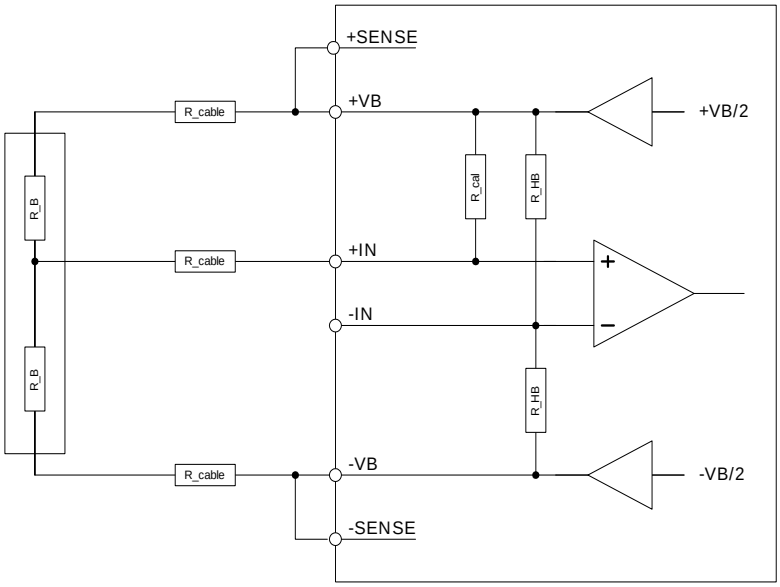
Half-bridge, single line-Sense

- 4-wire connection
- Only one SENSE-line is used (single line-Sense):
  Compensation of the influence of symmetric cable resistances.
  +SENSE or –SENSE can be used, recognized automatically, unused SENSE left open.
- Calibration resistor for shunt calibration of external half-bridge arm;

for long cables in CF mode, reduced precision due to phase errors.

- Internal half-bridge completion fed by ±VB, therefore symmetric cable required, otherwise not only incorrect gain correction but also corresponding offset drift!

Connection scheme: Half-bridge, single line-Sense

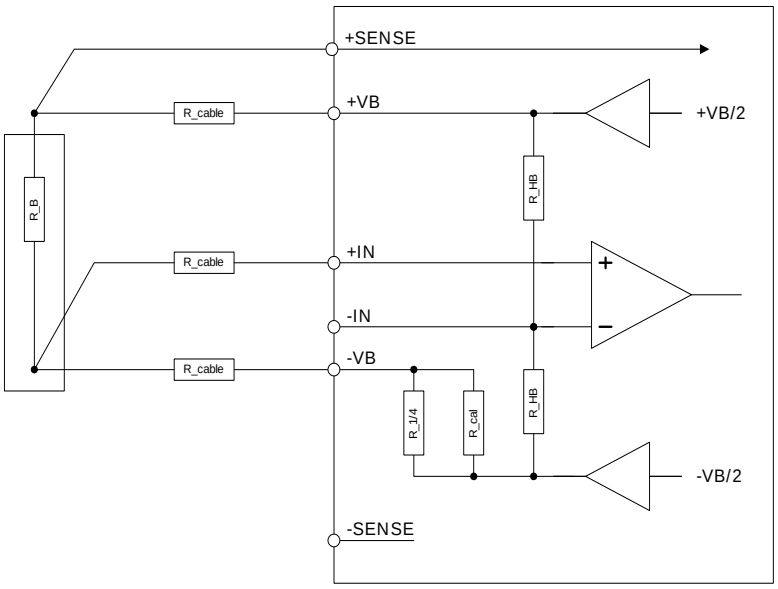


Half-bridge, single line-Sense

- 3-wire connection
- No SENSE-line used, SENSE terminals to be left open of jumpered to ±VB at the plug, in order to compensate the plug's contact resistance.
- Calibration resistor for shunt calibration on external half-bridge arm;
  for long cables in CF mode, reduced precision due to phase errors.
- Optional cable resistance calibration ("offline"):
  Cable resistance determined by means of shunt calibration and automatic calculation.
  Symmetric cabling required (also to +IN!).
  No acquisition of cable resistance drift, since it can only be performed offline before measurement.
- Internal half-bridge completion fed by ±VB, therefore symmetric cabling required, otherwise not only incorrect gain correction but also corresponding offset drift!

3.9.1.3 Quarter bridge

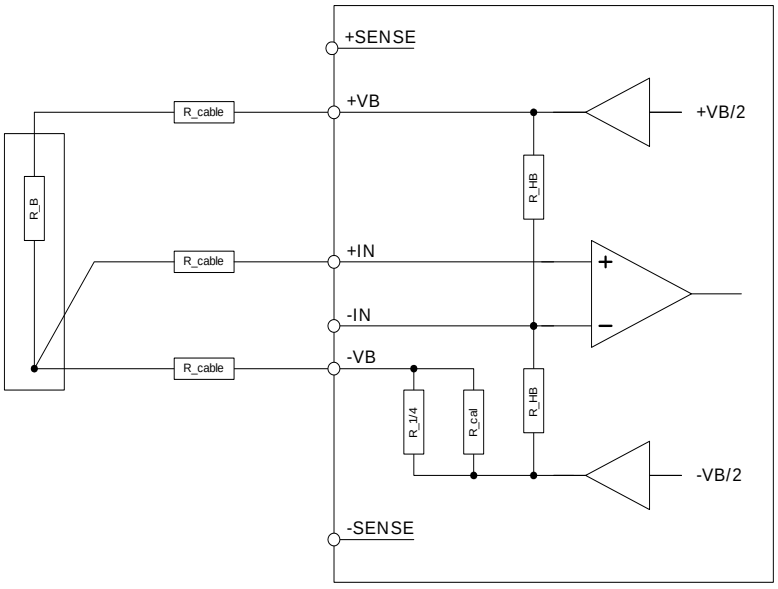
Connection scheme, quarter bridge, with Sense



Quarter bridge, with Sense

- 4-wire connection
- SENSE is used compensation of gain error caused by symmetric cable resistance (at VB). +SENSE or –SENSE can be used, recognized automatically, unused SENSE left open.
- Calibration resistor for shunt calibration: Shunt calibration at internal quarter-bridge completion. Shunt calibration can also be used with long cables in the CF mode!
- Symmetric cables required, otherwise corresponding offset drift!

Connection scheme: Quarter-bridge, without Sense



Quarter-bridge, without Sense

- 3-wire connection
- No SENSE-line is used, leave SENSE terminals open.
  +SENSE may also NOT be connected. Compensation of the plug contact resistance at VB is thus not possible (in contrast to the case of half-bridge 2-wire configuration).
- Symmetric cabling required, otherwise corresponding offset drift!
- Calibration resistance for shunt calibration: Shunt calibration at internal quarter-bridge completion.

Shunt calibration can also be used with long cables in the CF mode!

- For DC: Compensation of gain error due to cable resistance at VB by means of measurement and automatic compensation of the voltage drop along the cable between –VB and +IN
  Online-compensation, capture also of cable drift (which must be symmetric!)
- For CF: Optional cable resistance compensation ("offline"): Determination of and automatic accounting for cable resistance. Symmetric cable also required at +IN (!) No acquisition of cable resistance drift, since it can only be performed offline before measurement. Offline compensation measurement by means of shunt calibration at external quarter-bridge arm performed in DC mode and only covers resistance effects of cable!

3.9.1.4 Background info on quarter-bridge configuration

In ***quarter-bridge configuration*** the external ¼-bridge branch is connected via ***three cables***, where the two current-bearing leads "+VB" and "-VB" must be ***symmetric*** (same resistance, thus identical length and cross-section). Under these circumstances, their influence (in terms of the offset, not the gain) is compensated, so that no offset versus the (constant) internal half-bridge's potential arises.

If this symmetry condition is not met (e.g. if only two cables are used and the terminals "–VB" and "+IN" are directly jumpered at the terminal, the following offset drift would result due to the temperature-dependent cable resistance in series with the bridge impedance:

Assuming a (one-way) cable length of 1 m, we get:		
Cu-cable: 0.14 mm², 130 mΩ/m, cable length l=1 m	Cable Rk = 130 mΩ	
Temperature coefficient Cu:	4000 ppm / K	
Drift Rk:	0.52 mΩ / K	
Equivalent bridge drift (120 Ω bridge)	¼ 0,52 mΩ / (K *120 Ω)	= 1.1 µV/V / K
Example: Temperature change dT = 20 K	22 µV/V	(dT =20 K)

Cable resistance values which aren't ideally symmetric would have a proportionally equal effect:
e.g., 500 m of cable with 0.2% resistance difference would cause the same offset drift of 1.1 µV/V / K.

Along with the offset, a gain uncertainty given by the ratio between the cable resistance and the bridge impedance must also be taken into account. For 120 Ω bridges, it remains under 0.1% for cable lengths of approx. 1 m: (Cu-cable, 0.14 mm², 130 mΩ/m → cable Rk/Rb = 1/1000 for l = 0.9 m)

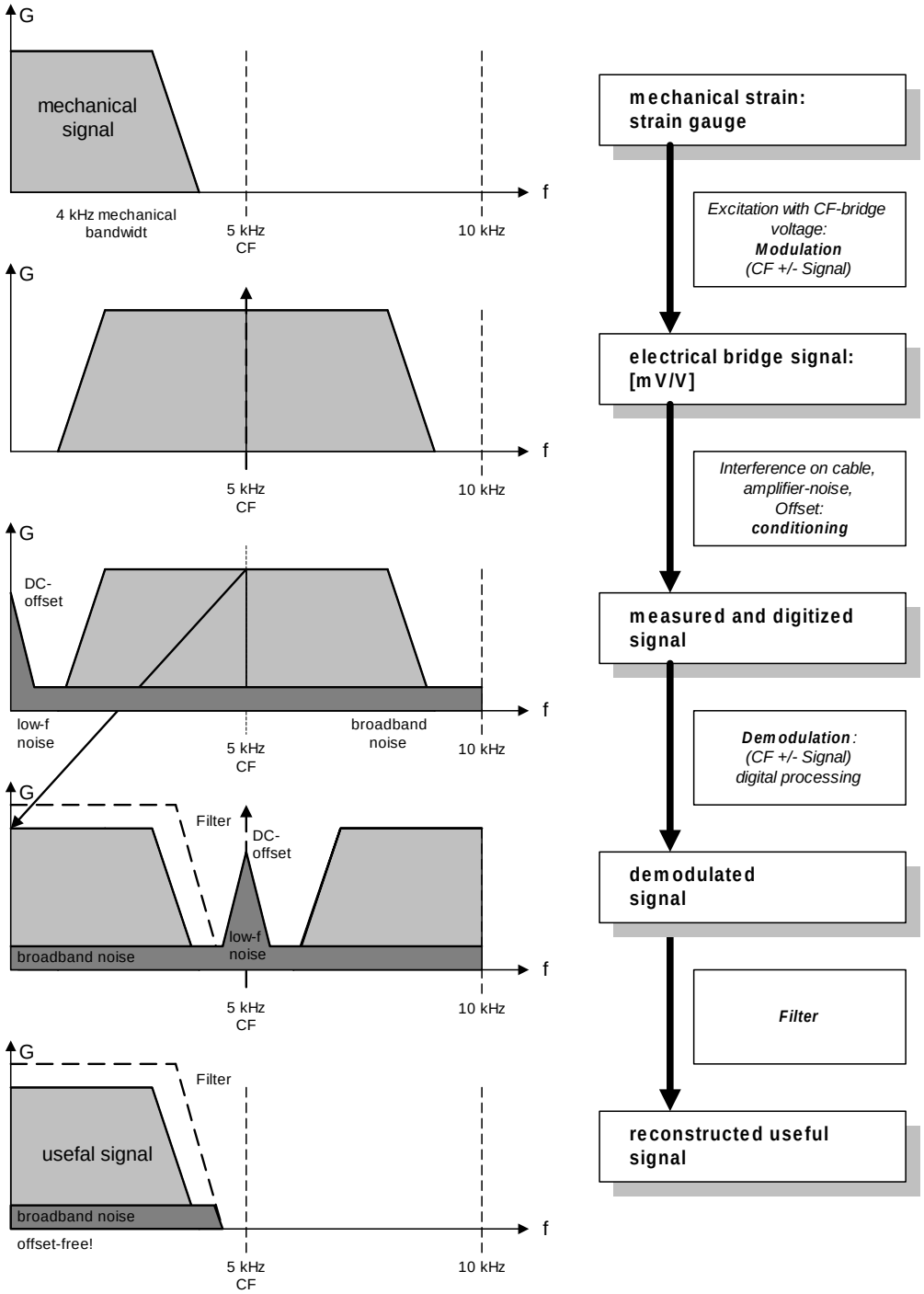
There are three different procedures for cable compensation:

- Connection of an additional 4th line: "+SENSE":
  - automatic calculated compensation on the condition of cable symmetry
  - online compensation procedure which also takes temperature drift into account
  - can be used with CF and DC-mode
- Evaluation of the voltage drop along the cable to "-VB" by means of measuring the voltage difference between the terminals "-VB" and "+IN":
  - automatic computed compensation on the condition of cable symmetry
  - online-compensation procedure which also accounts for temperature drift
  - only can be used for DC
- Offline cable resistance compensation by means of shunt calibration (on external quarter bridge):
  - automatic computed compensation on the condition of cable symmetry, including for the line "+IN"! This condition is generally not set for the 3-line Sense configuration!!
  - Assumption of nominal values for bridge impedance, shunt and gain: any deviation by the actual value in shunt calibration is interpreted as the influence of the cable resistance.
  - The underlying model results in a different correction than "classical" shunt calibration!
  - Offline compensation procedure which doesn't account for temperature drift
  - Used only with DC, since compensation is done only once, offline, if CF-mode is set, this procedure is performed in DC mode.

3.9.2 Carrier frequency amplifier: Modulation principle

Operational principle for the effective suppression of low-frequency disturbances, e.g. 16 Hz, 50 Hz. These can work from the wiring or the measuring process and/or from low-frequency noise and offset drift and also from the process and the amplifier.

The following schematically description shows that carrier frequency amplifier is based on a modulation / demodulation process. This process support low-frequency and/or DC disturbances which are linked on electrical way. Carrier frequency amplifier is necessary for inductive sensors, e.g. LVDT.



3.9.3 Bandwidth

The channels' max. sampling rate is 20 kHz (50 µs). The analog bandwidth (without digital low-pass filtering) is 8.6 kHz (-3 dB) in DC mode and 3.9 kHz in CF mode (-3 dB).

3.9.4 Connection

DSUB-15 plugs can be used for the modules with DSUB connections, find here the pin configuration of the DSUB-plugs 189.

Note

The pin configuration of the CRPL/DSUB-BR-4-BR DSUB plug for C-60xx module and the pin configuration of ACC/DSUB(M)-B2 for the C-60xx-1 [-N] module is different. Please consider the notes to the SENSE (different clamp 5 and 6, 11 and 12) 110.

3.10 CS-7008-1 [-N], CL-7016-1 [-N] and CS-7008, CL-7016

CS-7008-1 [-N] and CL-7016-1 [-N] are 8- and 16-channel universal measurement devices, respectively, with sampling rates of up to 100 kHz per channel. They are especially well suited to frequently changing measurement tasks. Practically every sensor- or signal type can be connected directly to any of the measurement amplifier's all-purpose channels. The input channels are differential and equipped with per-channel signal conditioning including filters.

The predecessor models CS-7008 and CL-7016 (without *-1*) differ in the properties of their analog channels. The description below points out the differences.

Universal channels - not isolated

Parameter	typ.	min. / max.	Remarks
Measurement modes DSUB	bridge-sensor bridge: strain gauge voltage thermocouples Pt100 (3- and 4-wire configuration)		ACC/DSUB(M)-UNI2 (for all modes)
	current		ACC/DSUB(M)-I2 shunt-plug or single ended (internal shunt)
	charge		ACC/DSUB-Q2
	current fed sensors (IEPE/ICP)		ACC/DSUB-ICP2, ACC/DSUB-ICP-BNC (ICP™-, Deltatron®-, Piezotron®-Sensors)

To supply external sensors or bridges the module is equipped with a sensor supply module 132.

The analog channels supportsTEDS 29(Transducer Electronic Data Sheets (IEEE 1451)

The measurement inputs whose terminals are DSUB plugs (ACC/DSUB(M)-UN2 189) are for voltage, current, bridge PT100 and thermocouple measurements. In addition the use of an ICP-expansion plug are provided for. They are non-isolated differential amplifiers. They share a common voltage supply for sensors and measurement bridges.

The amplifiers used in the devices C-70xx-1 [-N] is a successor model of the amplifier in the C-70xx devices. Unless any limitations are mentioned, the following description also applies to the *C-70xx* devices.

The technical specs of the *CS-7008-1 [-N], CL-7016-1 [-N]* 161.

3.10.1 Voltage measurement

- Voltage: ±50 V to ±5 mV; DSUB-plug: ACC/DSUB-UNI2

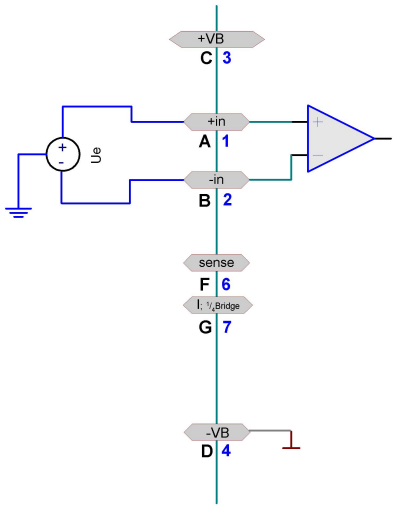
Within the voltage ranges ±50 V and ±20 V, a voltage divider is in effect; the resulting input impedance is 1 MΩ.

By contrast, in the voltage ranges ±10 V and ±5 mV, the input impedance is 20 MΩ. For the deactivated device, the value is approx. 1 MΩ.

In the input ranges <20 V, the common mode voltage* must lie within the ±10 V range. The range is reduced by half of the input voltage. The input configuration is differential and DC-coupled.

*The common mode voltage is the arithmetic mean of the voltages at the inputs +IN and -IN, referenced to the device ground. For instance, if the potential to ground is +10 V at +IN and +8 V at -IN, the common mode voltage is +9 V.

3.10.1.1 Voltage source with ground reference



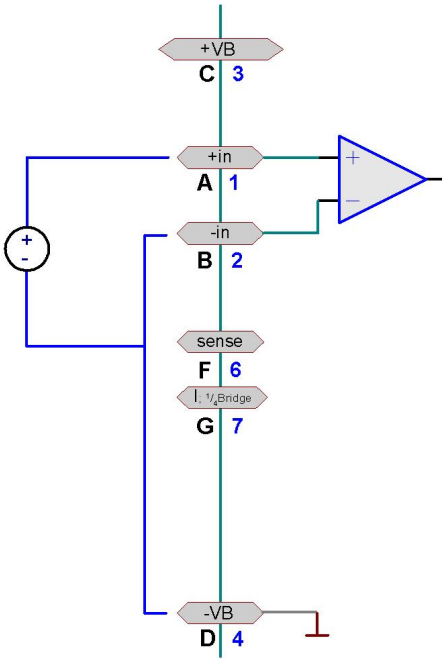
The voltage source itself already has a connection to the device's ground. The potential difference between the voltage source and the device ground must be fixed.

Example: The device is grounded. Thus, the input *-VB(D*) is also at ground potential. If the voltage source itself is also grounded, it's referenced to the device ground. It doesn't matter if the ground potential at the voltage source is slightly different from that of the device itself. But the maximum allowed common mode voltage must not be exceeded.

Important: In this case, the negative signal input *-in(B)* may not be connected with the device ground *-VB(D*). Connecting them would cause a ground loop through which interference could be coupled in.

In this case, a genuine differential (but not isolated!) measurement is carried out.

3.10.1.2 Voltage source without ground reference

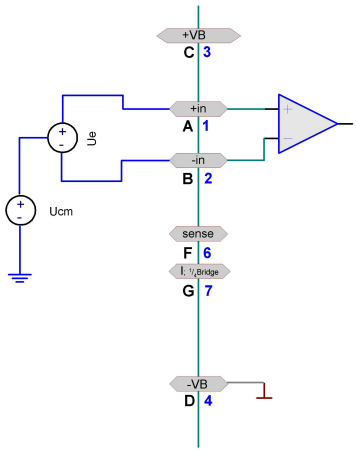


The voltage source itself is not referenced to the amplifier ground but is instead isolated from it. In this case, a ground reference must be established. One way to do this is to ground the voltage source itself. Then it is possible to proceed as for Voltage source with ground reference 120. Here, too, the measurement is differential. It is also possible to make a connection between the negative signal input and the device ground, in other words to connect *-in(B)* and *-VB(D)*.

Example: An ungrounded voltage source is measured, for instance a battery whose contacts have no connection to ground. The device module is grounded.

Important: If *-in(B)* and *-VB(D)* are connected, care must be taken that the potential difference between the signal source and the device doesn't cause a significant compensation current. If the source's potential can't be adjusted (because it has a fixed, overlooked reference), there is a danger of damaging or destroying the amplifier. If *-in(B)* and *-VB(D)* are connected, then in practice a single-end measurement is performed. This is no problem if there was no ground reference beforehand.

3.10.1.3 Voltage source at a different fixed potential



The common mode voltage (Ucm) has to be less than ±10 V. It is reduced by ½ input voltage.

Example: Suppose a voltage source is to be measured which is at a potential of 120 V to ground. The system itself is grounded. Since the common mode voltage is greater than permitted, measurement is not possible. Also, the input voltage difference to the amplifier ground would be above the upper limit allowed. For such a task, the *C-70xx-1 [-N]* cannot be used!

3.10.2 Bridge measurement

Measurement of measurement bridges such as strain gauges.

The measurement channels have an adjustable DC voltage source which supplies the measurement bridges. The supply voltage for a group eight inputs is set in common. The bridge supply is asymmetric, e.g., for a bridge voltage setting of VB=5 V, Pin +VB (C) is at +VB=5 V and Pin -VB (D) at -VB=0 V. The terminal –VB is simultaneously the device's ground reference.

Per default 5 V and 10 V can be selected as bridge supply. As an option the amplifier can be build with 2.5 V bridge supply. Depending on the supply set, the following input ranges are available:

Bridge voltage [V]	Measurement range [mV/V]
10	±1000 to ± 0.5
5	±1000 to ± 1
2.5	±1000 to ± 2

Fundamentally, the following holds: For equal physical modulation of the sensor, the higher the selected bridge supply is, the higher are the absolute voltage signals the sensor emits and thus the measurement's **signal-to-noise ratio** and drift quality. The limits for this are determined by the maximum available current from the source and by the **dissipation** in the sensor (temperature drift!) and in the device (power consumption!)

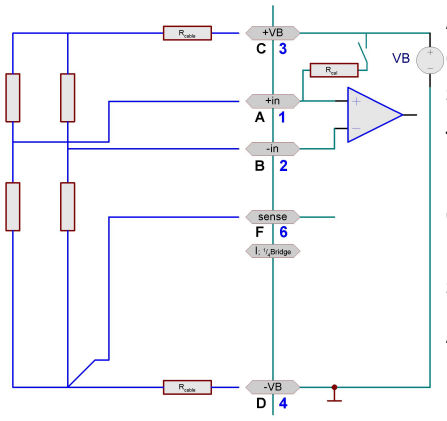
- For typical measurements with **strain ga**uges, the ranges 5 mV/V to 0.5 mV/V are particularly relevant.
- There is a maximum voltage which the **potentiometer sensors** are able to return, in other words max. 1 V/V; a typical range is then 1000 mV/V.

Bridge measurement is set by selecting as measurement mode either Bridge: Sensor or Bridge: Strain gauge in the operating software. The bridge circuit itself is then specified under the tab Bridge circuit, where quarter bridge, half bridge and full bridge are the available choices.

Note

We recommend setting channels which are not connected for voltage measurement at the highest input range. Otherwise, if unconnected channels are in quarter- or half-bridge mode, interference may occur in a shunt calibration!

3.10.2.1 Full bridge



A full bridge has four resistors, which can be four correspondingly configured strain gauges or one complete sensor which is a full sensor internally.

The full bridge has five terminals to connect. Two leads *+VB(C)* and *-VB(D)* serve supply purposes, two other leads *+in (A)* and *-in(B)* capture the differential voltage. The 5th lead *sense(F)* is the Sense lead for the lower supply terminal, which is used to determine the single-sided voltage drop along the supply line.

Assuming that the other supply cable *+VB (C)* has the same impedance and thus produces the same voltage drop, no 6th lead is needed. The Sense lead makes it possible to infer the measurement bridge's true supply voltage, in order to obtain a very exact measurement value in mV/V.

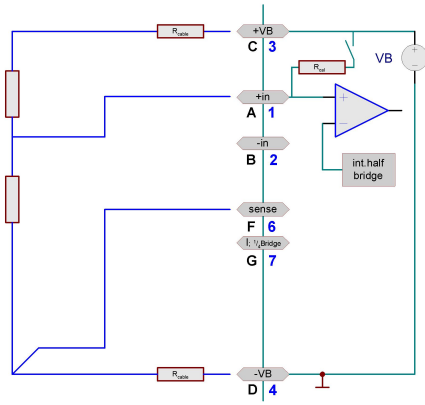
Please note that the maximum allowed voltage drop along a cable may not exceed approx. 0.5 V. This determines the maximum possible cable length.

If the cable is so short and its cross section so large that the voltage drop along the supply lead is negligible, the bridge can be connected at four terminals by omitting the Sense line.

Note

For the predecessor model *C-70xx pin sense(F)* must never be unconnected! In that case, *sense(F)* and *-VB (D)* must be jumpered.

3.10.2.2 Half bridge



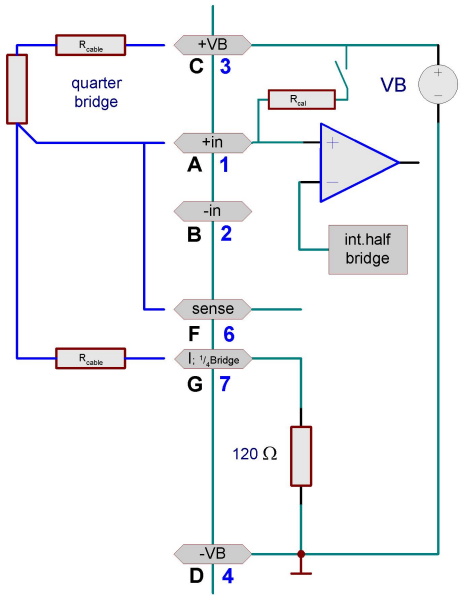
A half bridge may consist of two strain gauges in a circuit or a sensor internally configured as a half bridge, or a potentiometer sensor. The half bridge has 4 terminals to connect. For information on the effect and use of the *sense (F)* lead, see the description of the full bridge 122.

The amplifier internally completes the full bridge itself, so that the differential amplifier is working with a full bridge.

Note

It is important that the measurement signal of the half bridge is connected to *+IN (A).* The *IN (B)* access leads to implausible measured values and influences the neighbor channels.

3.10.2.3 Quarter bridge



A quarter bridge can consist of a single strain gauge resistor.

C-70xx-1 [-N] internally completes an additional 120 Ω that can be switched to a 350 Ω quarter bridge.

For quarter bridge measurement, only 5 V can be set as the bridge supply.

The quarter bridge has 3 terminals to connect. Refer to the description of the full bridge for comments on the Sense lead. However, with the quarter bridge, the Sense lead is connected to *+in(A)* and *sense(F)* jointly.

If the sensor supply is equipped with the option "±15 V", a quarter bridge measurement is not possible. The pin *I_1/4Bridge* for the quarter bridge completion is used for –15 V instead.

Note

- The predecessor model C-70xx comes with a 120 Ω internal bridge completion resistor. A 350 Ω completion resistor is alternatively possible for the purpose of quarter bridge measurement. When using this option, the scope of available functions is limited:
- No direct current measurement 125 with the standard included connector ACC/DSUB-UNI2 is possible, but only with the optional ACC/DSUB-I2 connector with a 50 Ω shunt resistor (differential measurement).

3.10.2.4 Sense and initial unbalance

The **SENSE** lead serves to compensate voltage drops due to cable resistance, which would otherwise produce noticeable measurement errors. If there are no sense lines, then C-70xx **SENSE (F)** must be connected in the terminal plug according to the sketches above.

Bridge measurements are relative measurements (**ratiometric procedure**) in which the fraction of the bridge supply fed in which the bridge puts out is analyzed (typically in the 0.1 % range, corresponding to 1 mV/V). Calibration of the system in this case pertains to this ratio, the bridge input range, and takes into account the momentary magnitude of the supply. This means that the bridge **supply's actual magnitude** is not relevant and need not necessarily lie within the measurement's specified overall accuracy.

Any initial unbalance of the measurement bridge, for instance due to mechanical pre-stressing of the strain gauge in its rest state, must be zero-balanced. Such an unbalance can be many times the input range (bridge balancing). If the initial unbalance is too large to be compensated by the device, a larger input range must be set.

Possible initial unbalance

input range [mV/V]	bridge balancing (VB = 2.5 V) [mV/V]	bridge balancing (VB = 5 V) [mV/V	bridge balancing (VB = 10 V) [mV/V
±1000	200	500	240
±500	500	100	700
±200	40	400	60
±100	140	20	200
±50	200	70	10
±20	20	100	35
±10	30	14	50
±5	7	18	7
±2	9	3,5	10
±1	-	4,5	2
±0,5	-	-	5

3.10.2.5 Balancing and shunt calibration

The amplifier offers a variety of possibilities to trigger bridge balancing:

- Balancing / shunt calibration via the on the Amplifier balance tab.
- Balancing / shunt calibration via display, for description see manual imc DEVICES / imc STUDIO
- In shunt calibration, the bridge is unbalanced by means of a 59.8 kΩ or 174.7 kΩ shunt (between +VB and +IN). The results are:

Bridge resistance	120 Ω	350 Ω
59.8 kΩ 174.7 kΩ	0.5008 mV/V 0.171 mV/V	1.458 mV/V 0.5005 mV/V

The procedures for balancing bridge channels also apply analogously to the voltage measurement mode with zero-balancing.

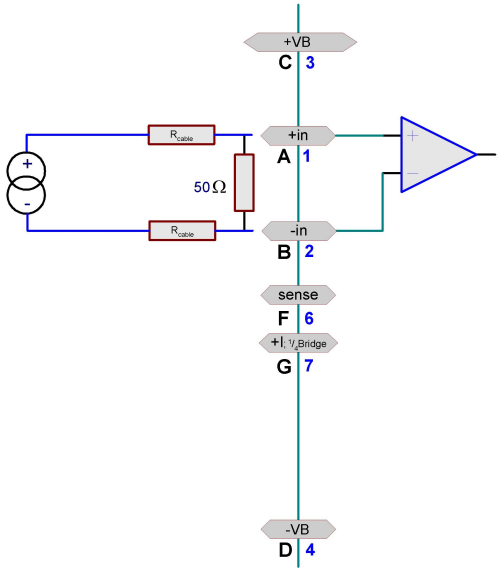
Hinweis

- We recommend setting channels which are not connected for voltage measurement at the highest input range. Otherwise, if unconnected channels are in quarter- or half-bridge mode, interference may occur in a shunt calibration!

3.10.3 Current measurement

3.10.3.1 Differential current measurement

- Current: ±50 mA to ±1 mA



For current measurement could be used the DSUB plug ACC/ DSUB-I2. That connector comes with a 50 Ω shunt and is not included with the standard package. It is also possible to measure a voltage via an externally connected shunt. Appropriate scaling must be set in the user interface. The value 50 Ω is just a suggestion. The resistor needs an adequate level of precision. Pay attention to the shunt's power consumption.

The **maximum common** mode voltage must be in the range **±10 V** for this circuit, too. This can generally only be ensured if the current source itself already is referenced to ground. If the current source is ungrounded a danger exists of exceeding the maximum allowed overvoltage for the amplifier. The current source may need to be referenced to the ground, for example by being grounded.

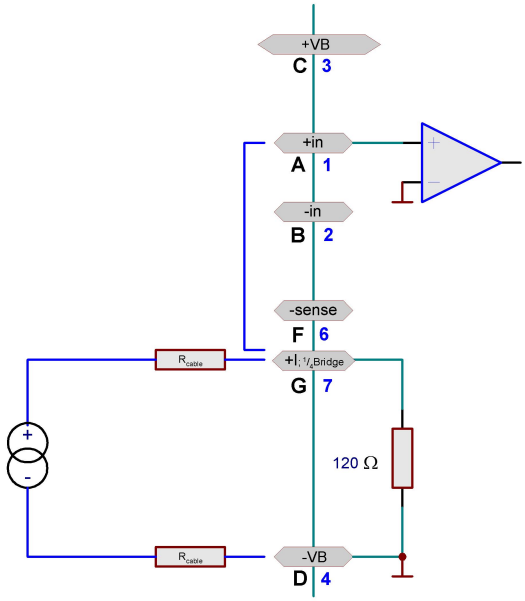
The sensor can also be supplied with a software-specified voltage via Pins *+VB(C)* and *-VB(D)*.

Note

- Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc DEVICES interface.
- The scaling factor is entered as 1/R and the unit as A (0.02 A/V = 1/50 Ω).

3.10.3.2 Ground-referenced current measurement

- Current: ±50 mA to ±2 mA



In this circuit, the current to be measured flows through the 120 Ω shunt in the amplifier. Note that here, the terminal *-VB(D)* is simultaneously the device's ground. Thus, the measurement carried out is single-end or ground referenced. The potential of the current source itself may be brought into line with that of the units ground. In that case, be sure that the device unit itself is grounded.

In the settings interface, set the measurement mode to Current.

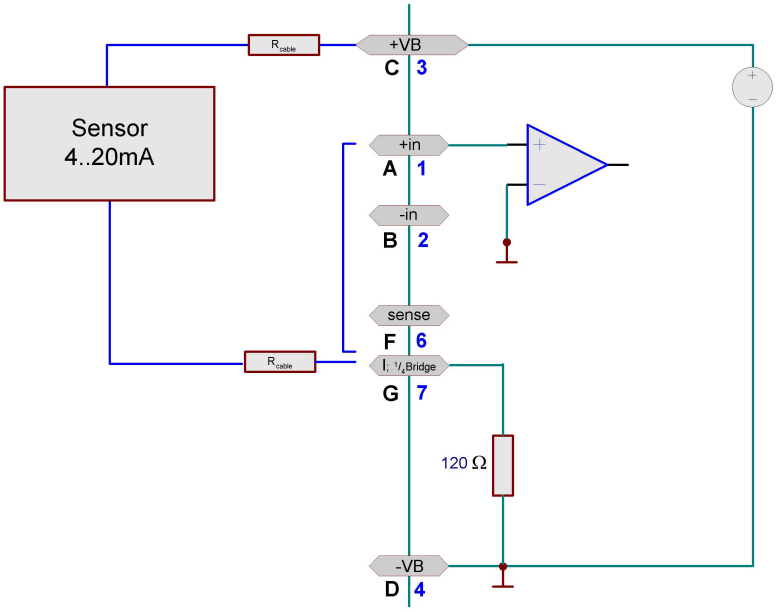
Note that the jumper between *+IN(A)* and *+I; ¼Bridge(G)* should be connected right inside the connector.

Note

- For an (optional) sensor supply with ±15 V ground referenced current measurement is not possible. The pin I;¼Bridge is used as –15 V pin.
- For the former C-70xx equipped with a 350 Ω quarter bridge completion, ground referenced current measurement is not possible!

3.10.3.3 2-wire for sensors with a current signal and variable supply

- E.g. for pressure transducers 4 mA to 20 mA.



Transducers which translate the physical measurement quantity into their own current consumption and which allow variable supply voltages can be configured in a two-wire circuit. In this case, the device has its own power supply and measures the current signal.

In the settings dialog on the index card *Universal amplifiers / General*, a supply voltage is set for the sensors, usually 24 V. The channels must be configured for Current measurement.

The sensor is supplied with power via Terminals *+VB(C)* and *+I; ¼Bridge(G)*

The signal is measured by the unit between *+IN(A)* and *-VB(D)*. For this reason, a wire jumper must be positioned between *Pins +IN(A)* and *+I; ¼Bridge(G)* inside the connector pod.

Note

- There is a voltage drop across the resistances of the leadwires and the internal measuring resistance of 120 Ω which is proportional to the amperage. This lost voltage is no longer available for the supply of the transducer (2.4 V = 120 Ω * 20 mA). For this reason, you must ensure that the resulting supply voltage is sufficient. It may be necessary to select a leadwire with a large enough cross-section.
- For the former *C-70xx*: If the amplifier is equipped with a 350 Ω quarter bridge completion, ground referenced current measurement is not possible! Thus this operation is not possible, too.

3.10.4 Temperature measurement

The amplifier channels are designed for direct measurement with **thermocouples** and **Pt100-sensors**. Any combinations of the two sensor types can be connected.

Note on making settings with imc DEVICES

A temperature measurement is a voltage measurement whose measured values are converted to physical temperature values by reference to a characteristic curve. The characteristic curve is selected from the Base page of the imc DEVICES configuration dialog. Amplifiers which enable bridge measurement, must first be set to Voltage mode (DC), in order for the temperature characteristic curves to be available on the Base page.

3.10.4.1 Thermocouple measurement

The cold junction compensation necessary for thermocouple measurement is built-in. In the imc connector ACC/DSUB-UNI2, the cold junction is located directly under the clamp terminal strip and is measured automatically.

Note

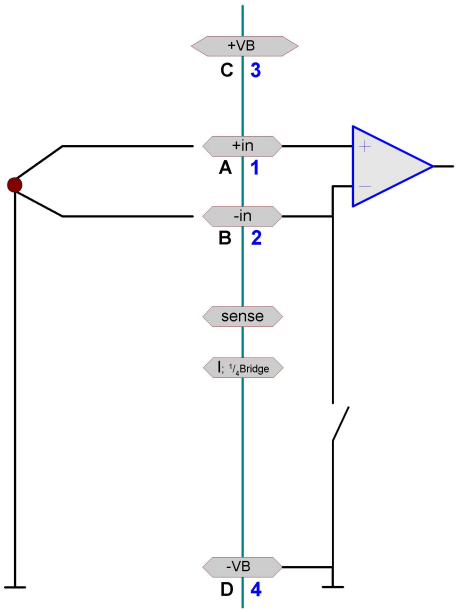
- In the imcDevices user interface, the option Isolated thermocouple (default setting) must be activated under Settings - Configuration - Amplifier. This only is available with Coupling DC.
- For former version *C-70xx*: When using thermocouples, the ICP-supply is no longer available.
- A description of the available thermocouples 31.

3.10.4.1.1 Thermocouple mounted with ground reference

The thermocouple is mounted in such a way that it already is in electrical contact with the device ground / chassis.

This is ensured by attaching the thermocouple to a grounded metal body, for instance. The thermocouple is connected for differential measurement. Since the unit is grounded itself, the necessary ground reference exists.

In the operating software, don't activate the option "***Isolated thermo couple***" at the amplifier tab.



Thermocouple measurement with ground reference

It is not a problem if the ground potential at the thermocouple differs from that of the device units by a few volts. However, the maximum allowed common mode voltage may not be exceeded.

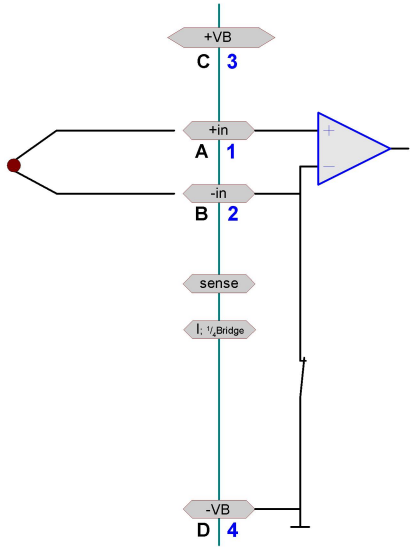
Important Note

- The negative signal input -IN may not be connected to amplifier ground point -VB(D). Connecting them would cause a ground loop through which interference could be coupled in.
- If you accidentally activate the option "Isolated thermo couple" on the Amplifier page, there is a danger that a large compensation current will flow through the thermocouple's (thin) line and the connector plug. This can even lead to the destruction of the amplifier. Compensation currents are a danger with every single end measurement. For that reason, single end measurement is really only allowed -and only then really necessary- if the thermocouple has no ground reference of its own.

3.10.4.1.2 Thermocouple mounted without ground reference

The thermocouple is installed with electrical isolation from the device's Ground / Chassis and is therefore not connected with the device's ground. This is achieved by, among other techniques, having the thermocouple adhere to non-conducting material. As a result, the thermocouple's voltage floats freely against the amplifier ground voltage.

In this case, the amplifier must provide the necessary ground potential.



Thermocouple measurement without ground reference

In the operating software, activate "***Isolated thermo couple***" at the amplifier tab.

In this measurement mode, the unit itself provides the ground reference by having Terminals *-IN(B)* and *-VB(D)* connected internally. This connection is only made in the Thermocouple mode and not with voltage measurements.

Warning: The thermocouple itself **may not be ground referenced!**

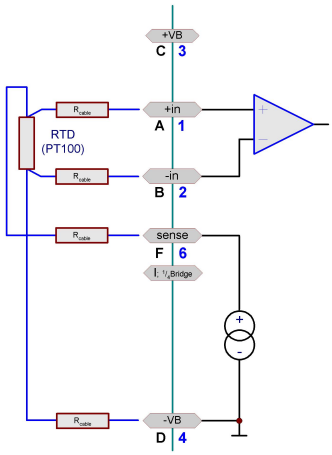
If it was mounted with a ground reference, there is a danger that a large compensation current will flow through the thermocouple's (thin) line and the connector plug. This can even lead to the destruction of the amplifier. Compensation currents are a danger with every single end measurement. For that reason, single end measurement is really only allowed -and only then really necessary- if the thermocouple has no ground reference of its own.

3.10.4.2 Pt100/ RTD measurement

- DSUB-plug: ACC/DSUB-UNI2

Pt100. RTD, platinum resistor thermometer. Along with thermocouples, Pt100 can be connected directly in 4-wire-configuration. The 4-wire measurement returns more precisely results since it does not require the resistances of both leads which carry supply current to have the same magnitude and drift. Each sensor is fed by its own current source with approx. 1.2 mA.

3.10.4.2.1 Pt100 in 4-wire configuration



The Pt100 is supplied by 2 lines. The other two serve as Sense-leads. By using the Sense-leads, the voltage at the resistor itself can be determined precisely. The voltage drop along the conducting cable thus does not cause any measurement error.

The measurement inputs *+/-IN* carry practically no current.

The 4-wire configuration is the most precise way to measure with a Pt100. The module performs a genuine differential measurement.

Note

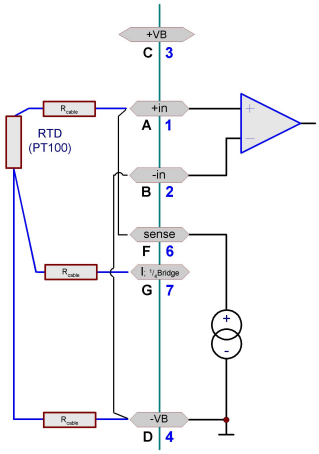
Pt100 in 4-wire configuration is not possible for
- an (optional) sensor supply with ±15 V.
- the former C-70xx equipped with a 350 Ω quarter bridge completion.

3.10.4.2.2 Pt100 in 2-wire configuration

Use the software to set a Pt100 4-wire configuration, because the connection is made in the same way as for the 4-wire case. The difference is that *+IN(A)/sense(F)* and *–IN(B)/-VB(D)* must be jumpered inside the connector.

Note that the total **cable resistance** contributes to **measurement error**, and that this method is the most imprecise and not to be recommended.

3.10.4.2.3 Pt100 in 3-wire configuration



The Pt100 is supplied by 2 lines. The other one serve as sense-lead. By using the Sense-lead, the voltage at the resistor itself can be determined precisely. The voltage drop along the conducting cable thus does not cause any measurement error.

It is important, that the connection between *+IN(A) to Sense* and *-IN(B) to -VB(D)* is made directly at the module.

3-wire configuration is not always as precise as 4-wire configuration. When in doubt, 4-wire configuration is preferable.

Note

Pt100 in 3-wire configuration is not possible for:
- an (optional) sensor supply with ±15 V.
- the former C-70xx equipped with a 350 Ω quarter bridge completion.

3.10.4.3 Probe-breakage recognition

The amplifier comes with the ability of probe-breakage recognition.

Thermocouple: If at least one of the thermocouple's two lines breaks, then within a short time (only a few samples), the measurement signal generated by the amplifier approaches the bottom of the input range in a defined pattern. The actual value reached depends on the particular thermocouple. In the case of Type K thermocouples, this is around 270°C. If the system is monitoring a cutoff level with a certain tolerance, e.g. Is the **measured value <-265°C**, then it's possible to conclude that the probe is broken, unless such temperatures could really occur at the measurement location.

The probe-breakage recognition is also triggered if a channel is parameterized for "Thermocouple" and measurement starts without any thermocouple being connected. If a thermocouple is later connected after all, it would take the period of a few measurement samples for transients in the module's filter to subside and the correct temperature to be indicated. Note also in this context that any thermocouple cable's connector which is recently plugged into the amplifier is unlikely to be at the same temperature as the module. Once the connection is made, the temperatures begin to assimilate. Within this phase, the Pt100 built into the connector may not be able to indicate the real junction temperature exactly. This usually takes some minutes to happen.

RTD/Pt100: If the leads to the Pt100 are broken, then within a short time (only a few samples), the measurement signal generated by the amplifier approaches the bottom of the input range, to about 200°

C, in a defined pattern. If the system is monitoring a cutoff level with a certain tolerance, e.g. Is the **measured value <-195°C**, then it's possible to conclude that the probe is broken, unless such temperatures could really occur at the measurement location. In case of a short-circuit, the nominal value returned is also that low.

In this context, note that in a 4-wire measurement a large variety of combinations of broken and shorted leads are possible. Many of these combinations, especially ones with a broken Sense lead, will not return the default value stated.

3.10.5 Current fed sensors

Measurement of current-fed sensors, e.g. ICPs is possible with the DSUB-15 imc plugs. Therefore the special connector ACC/DSUB-ICP2 is required.

For measurement of current-fed sensors, the special connector ACC/DSUB-ICP2 68 is required.

For the supply of the special connector, the module provides a 5 V (Vcc) voltage at PIN17. This voltage is short-circuit proof and independent of the voltage supply module.

For the description of the measurement with current feed sensors, see here 68.

Note

- With the former Cx-70 this mode is not possible, if a channel has been set to thermocouple measurement.
- The ACC/DSUB-ICP2 plug cannot be used together with triaxials.

3.10.6 Charging amplifier

C-70xx-1 [-N] supports the DSUB-Q2 charge amplifier, which is a 2-chanel pre-amp in the shape of an imc terminal connector enabling connection of two charge sensors via BNC.

The charge amplifier is recognized and adjusted automatically if either DC- or AC charge coupling is selected in the amplifier dialog. In order for these two coupling types to be displayed for the channel selected, the charge amplifier must be read by means of TEDS technology or it must be adjusted according to an appropriate sensor database entry.

The description of the DSUB-Q2 74 and the technical specification.

3.10.7 Userdefined characteristic curves

Userdefined characteristic curves created e.g. by imc SENSORS, can be proceeded with C-70xx.

Note

Support for C-70xx-1 [-N] is in preparation.

3.10.8 Sensor supply module

C-70xx-1 [-N] channels are enhanced with a sensor supply unit, which provides an adjustable supply voltage for active sensors. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

The supply voltage can only be set for a group of eight channels.

The supply outputs are electronically protected internally against short circuiting to ground. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

The supply voltage can only be set for all measurement inputs in common. The voltage selected is also the supply for the measurement bridges. If a value other than 5V or 10V is set, bridge measurement is no longer possible!

3.10.9 Bandwidth

The channels' maximum sampling rate is 100 kHz(10 µs).

The analog bandwidth (without digital low-pass filtering) is 48 kHz (-3 dB). For the former *CS-7008, CL-7016* the bandwidth has been limited to 14 kHz.

3.10.10 Connection

The analog channels are equipped with **DSUB-15** plugs . Find here the pin configuration of the DSUB-15 plugs 189

3.11 CS-8008

CS-8008 is an 8-channel universal measurement device with sampling rates of up to 100 kHz and a bandwidth of 45,3 kHz (@ 0,005 dB) per channel.

With active thirds, the sampling rate is up to 50 kHz with a bandwidth of 22,4 kHz (@-3 dB).

Any kind of ICP™ sensors such as DeltaTron® accelerometers and microphones are supplied with power and can be directly connected to the measurement amplifiers, with the 1/3-octave spectrum returned along with the signal's plot over time.

It is additionally possible to connect voltage or current signals at the differential input channels, which are each individually equipped with signal conditioning including filters.

Parameter	Value	Remarks
Measurement mode	current-fed ICP™ sensors such as DeltaTron® accelerometers and microphones voltage	with BNC connector

In conjunction with its operating software this device is immediately ready to take measurements, and all of its functions are operable.

Additionally, the device can be expanded into a complete workstation for noise and vibration analysis, by running the (optional) imc WAVE software. Along with a spectrum analyzer, there are packages for order tracking- and structure analysis for standards-compliant measurement of workplace noise, as well as pass-by analysis of noise from motor vehicles, and a module for free configuration of application-specific functions. Supplemental processing of the signals is possible thanks to the signal analysis software FAMOS, while interfaces to ME´Scope™ and µ-Remus™ are also available.

The technical specs of the CS-8008 [-N].

3.11.1 Voltage measurement

Voltage measurements can handled as single ended- as well as differential measurements. In addition you can choose between AC and DC. In the ±25 V and ±50 V ranges, a divider is switched in between which lead to a reduced input impedance of 1 MΩ or 2 MΩ.

We recommend the differential mode, if the source which should be measured has a low impedance path to ground. In cases of isolated sources single-ended should be chosen to avoid floating problems and better noise immunity. The various sources of interference can affect the measurement by a variety of means, depending on the measurement environment; even the setting AC or DC for the coupling an affect things differently. Therefore, check each individual case with multiple settings in order to achieve optimal measurement results.

3.11.2 1/3-octave calculation

The online processor on the amplifier card is able to calculate 1/3-octaves in real-time. The calculated 1/3-octave channels appear in the software after the amplifier's analog input channels. A 1/3-octave channel's data stream must be processed with the imc Online FAMOS function AudioBoardThirds, in order for the 1/3-octave spectra to be displayed properly.

Note

If the calculation of the 1/3-octaves is only enabled after delivery, the incremental numbering of the channels in the software is shifted upward. In this way, it can happen that the channel designation on the device panel will deviate from its designation in the software interface.

3.11.3 Current fed sensors

The use of ICP™ e.g. DeltaTron-sensors® is supported by a 4mA current source. The sensor information can read directly from the sensor in accordance to the standard „TEDS - Transducer Electronic Data Sheets (IEEE 1451)“.

Note

Once the TEDS information (CLASS1, content ="AC with current feed") has been imported, the only available setting for the coupling type is "AC with current feed". In order for DC or AC coupling to be displayed as options, the channel must be disassociated from the sensor information:
imc DEVICES Configuration --> Sensor --> Connected to sensor --> "Use channel without sensor information!".

imc STUDIO: Setup\TEDS -> "Reset channel's sensor information"

3.11.4 Bandwidth

The channels' max. sampling rate is 100 kHz (10 µs sampling interval) without and 50 kHz (20 µs) with thirds calculation.

The analog bandwidth (without digital low-pass filtering) is 48,6 kHz without and 22,4 kHz with thirds calculation (-3 dB).

3.11.5 Connection

The signals are connected via BNC sockets.

Technical specifications

4.1 General technical specs for all devices of imc C-SERIES

Parameter	Value	Remarks
Housing type	Alu profile plastic portable housing	CS CL
Ingress Protection	IP20	
Terminal connection		
Terminal connection (DSUB-15) analog inputs	see specs of your device	
Terminal connection (DSUB-15) DI, DO, INC, DAC	ACC/DSUB(M)-DI4-8 ACC/DSUB(M)-DO8 ACC/DSUB(M)-ENC4 ACC/DSUB(M)-DAC4	8 digital inputs 8 digital outputs 4 counter inputs 4 analog outputs
Further terminal connections	RJ45 CF-Card slot 2x DSUB-9 DSUB-9 DSUB-9 BNC LEMO FGG.1B.302.CLAD62Z LEMO FGG.0B.302.CLAD62Z	Ethernet (10/100 MBit), PC/network removable storage two CAN-nodes external Display (CS) external GPS module synchronization supply (CS) supply (CL)
Weight without table-top power adapter	approx. 2 kg approx. 3.5 kg	CS CL
Dimensions (WxHxD) in mm	95 x 111 x 185 270 x 85 x 300	CS CL

Power supply		
Parameter	**Value**	**Remarks**
DC input supply voltage	10 V to 32 V DC	
Isolation of supply input	not-isolated isolated	CS CL
Power adapter	110 V / 230 V AC	external adapter, included in delivery
Auto start upon power up	configurable	automatic start of measurement
Automatic shutdown with data saving upon power fail	yes	
UPS	battery: lead-gel	uninterruptable power supply
UPS buffer time constant	1 sec (with CS) 30 sec. (with CL)	maximum duration of a continuous outage before triggering device shutdown
Internal battery voltage	4 V 24 V	CS CL

Power supply		
Parameter	**Value**	**Remarks**
Effective buffer capacity	≥3,5 Wh ≥5,1 Wh	typ. 23°C, battery fully charged CS CL
Minimum charging time for 1 min. buffer duration	≤19 min ≤21 min.	for empty battery, 23°C CS CL
Charging time for empty battery	6 h	device activated
Charging capacity	1.1 W 1.5 W	automatic charge control CS CL

Operating conditions	
Operating environment (standard)	dry, non corrosive environment within specified temperature range
Operating temperature (standard)	-10°C to +55°C no condensation
Operating temperature(extended)	-20°C to +85°C with condensation
Operating altitude	up to 2000 m
Relative humidity	80 % for less than 31°C, for more than 31°C linear declining to 50%, according DIN EN61010-1

Data acquisition and hardware options	
Max. aggregate sampling rate	400 kS/s
Sampling rate channel wise configurable in steps of 1-, 2-, 5	✓
Number of simultaneously applicable sampling rates (in one configuration)	2
Monitor channels (doubled channels with independent sampling and trigger configurations)	✓
Multi-triggered data acquisition: multitrigger and multi-shot	✓
Independent trigger machines (start/stop, arbitrary channel assignments)	48
Extensive intelligent trigger functions	✓
Direct onboard data reduction: arithmetic mean, min, max	✓
Extensive real-time calculation and control functions	✓ included in standard deliveries (via imc Online FAMOS)
Synchronization	DCF 77, IRIG-B (auto detect) NTP GPS
External GPS signal receiver	O
Internal WiFi (WLAN) adaptor	O IEEE 802.11g (1 Antenna) max. 54 MBit/s

Data storage	
internal removable storage	CF-Card (covered CF slot)
internal hard drive	O (with CL)
Any memory depth with pre- and post triggering	✓
Circular buffering	✓

4.2 Cx-10xx analog inputs

Parameter	Value	Remarks
Analog inputs	16 32	CS CL
Measurement modes	voltage current current feed sensors	 with shunt plug (ACC/DSUB-I4) with plug (ACC/DSUB-ICP4(-IP65))
Terminal connection (DSUB-15) analog inputs	ACC/DSUB(M)-U4 ACC/DSUB(M)-I4 ACC/DSUB-ICP4	voltage current current feed sensors

Sampling rate, Bandwidth, filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤20 kHz	per channel
Bandwidth	0 Hz to 5 kHz 0 Hz to 6.6 kHz	-0.1 dB -3 dB (analog AAF 5th order)
Filter (digital) cut-off frequency characteristic, order	2 Hz to 5 kHz	 Butterworth, Bessel (digital) low pass filter 8. order Anti-aliasing filter: Cauer 8. order with $f_{cutoff} = 0.4\ f_s$
TEDS	conform IEEE 1451.4 Class II MMI	
Auxiliary supply	+5 V (max. 160 mA / plug) not isolated	e.g. for ICP-extension plug

Voltage measurements			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±10 V, ±5 V, ±2.5 V, ±1 V, ±500 mV, ±250 mV		
Overvoltage protection		±40 V	permanent channel to chassis
Input impedance	20 MΩ	±1 %	differential, >10 kΩ off-state
Gain: uncertainty drift	0.02 % $\pm 8 ppm/K \cdot \Delta T_a$	≤0.05 % $\pm 30 ppm/K \cdot \Delta T_a$	of reading $\Delta T_a = \lvert T_a - 25°C \rvert$; ambient temp: T_a
Offset: uncertainty drift	0.02 % $\pm 18\ \mu V/K \cdot \Delta T_a$ $\pm 2\ \mu V/K \cdot \Delta T_a$	≤0.05 % $\pm 45\ \mu V/K \cdot \Delta T_a$ $\pm 5\ \mu V/K \cdot \Delta T_a$	of range ±10 V to ±2.5 V ±1 V to ±250 mV $\Delta T_a = \lvert T_a - 25\ °C \rvert$; ambient temp: T_a
Max. common mode voltage		±12 V	
Common mode rejection Ranges ±10 V to ±2.5 V ±1 V to ±250 mV	 -90 dB -108 dB	 -80 dB -97 dB	common mode test voltage: $\pm 10\ V_{=}$ and 7 Vrms, 50 Hz
Channel to channel crosstalk Ranges 10 V to ±2.5 V	 -90 dB		test voltage: $\pm 10\ V_{=}$ and 7 Vrms, 0 Hz to 50 Hz; range: ±10 V

Voltage measurements			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
±1 V to ±250 mV	-116 dB		
Noise	12 µVrms		bandwidth: 0.1 Hz to 1 kHz

Current measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±50 mA, ±20 mA, ±10 mA, ±5 mA		50 Ω shunt in terminal plug
Max. over load	±60 mA		permanent
Input configuration	differential		50 Ω shunt plug (ACC/DSUB(M)-I4)
Gain: uncertainty drift	 0.02 % ±20 ppm/K·ΔT_a	 ≤0.06 % ≤0.1 % ±55 ppm/K·ΔT_a	of reading plus uncertainty of 50 Ω shunt ΔT_a=|T_a -25 °C|; ambient temp: T_a
Offset: uncertainty drift	 0.02 % ±30 nA/K·ΔT_a	 ≤0.05 % ±60 nA/K·ΔT_a	 of range ΔT_a=|T_a -25 °C|; ambient temp: T_a

Find here the description of the CS-1016 [-N], CL-1032 [-N] 81.

4.3 Cx-12xx analog inputs

Parameter	Value	Remarks
Analog inputs	8 24	CS CL
Measurement modes	voltage measurement current measurement current feed sensors	 shunt plug (ACC/DSUB(M)-I4) ICP4 extension plug ACC/DSUB-ICP4, ACC/DSUB-ICP-BNC
Terminal connection (DSUB-15) analog inputs	ACC/DSUB(M)-U4 ACC/DSUB(M)-I4 ACC/DSUB-ICP4	

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz	per channel
Bandwidth	0 Hz to 48 kHz 0 Hz to 30 kHz	-3 dB -0.1 dB
Filter (digital) cut-off frequency characteristic order	 10 Hz to 20 kHz 	 Butterworth, Bessel low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cutoff} = 0.4\ f_s$
Resolution	16 Bit	internal processing 24 Bit
TEDS	conforming to IEEE 1451.4 Class II MMI	ACC/DSUB(M)-TEDS-xx

General			
Parameter	**Value typ.**	**min./ max.**	**Remarks**
Overvoltage protection		 ±80 V ±50 V	permanent channel to chassis range >±10 V and device switched off range ≤±10 V
Input coupling	DC		
Input configuration	differential		
Input impedance	1 MΩ 20 MΩ	±1%	range: >± 10 V ≤ ± 10 V
Auxiliary supply voltage available current internal resistance	 +5 V >0.26 A 1.0 Ω	 ± 5% >0.2 A <1.2 Ω	for IEPE (ICP) plug independent of optional sensor supply, short circuit proof power per DSUB-plug

Voltage measurement			
Parameter	**Value typ.**	**min./ max.**	**Remarks**
Input ranges	±50 V, ±25 V, ±10 V, ±5V, ±2.5 V, ±1 V... ±5 mV		
Gain uncertainty	0.02 %	≤0.05 %	of reading
drift	10 ppm/K·ΔT_a	30 ppm/K·ΔT_a	ΔT_a=|T_a -25 °C|; ambient temp: T_a
Offset uncertainty	0.02 %	≤0.05 % ≤0.06 %	of range, in ranges (25°C): >±50 mV ≤±50 mV
drift	±40 µV/K·ΔT_a ±0.7 µV/K·ΔT_a ±0.1 µV/K·ΔT_a	±200 µV/K·ΔT_a ±6 µV/K·ΔT_a ±1.1 µV/K·ΔT_a	range >±10 V range ±10 V to ±0.25 V range ≤±0.1 V ΔT_a=|T_a –25°C| ambient temp T_a
Non-linearity	30 ppm	≤90 ppm	
Common mode rejection ranges ±50 V to ±25 V ±10 V to ±50 mV ±20 mV to ±5 mV	 80 dB 110 dB 138 dB	 >70 dB >90 dB >132 dB	Common mode voltage (DC..60 Hz): ±50 V ±10 V ±10 V
Noise	 3.6 μV_{eff} 0.6 μV_{eff} 0.14 μV_{eff}	 5.5 μV_{eff} 1.0 μV_{eff} 0.26 μV_{eff}	bandwidth 0.1 Hz to 50 kHz 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz

Current measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±1 mA		50 Ω shunt in terminal plug
Over load protection		±60 mA	permanent
Input configuration	differential		50 Ω shunt in terminal plug (ACC/DSUB-I4)
Gain: uncertainty drift	 0.02 % +15 ppm/K·ΔT_a	 ≤0.06 % ≤0.1 % +55 ppm/K·ΔT_a	of reading plus uncertainty of 50 Ω shunt ΔT_a=|T_a -25 °C|; ambient temp: T_a
Offset: uncertainty	 0.02 %	 ≤0.05 %	of range
Current noise	 40 nA_{eff} 0.7 nA_{eff} 0.17 nA_{eff}	 70 nA_{eff} 12 nA_{eff} 0.3 nA_{eff}	Bandwidth: 0.1 Hz to 50 kHz 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz

The description of the CS-1208-1 [-N], CL-1224-1 [-N] 82. The technical data of the sensor supply (option) 184.

4.4 CL-2108 general technical data

Technical datasheet Version 1.4

Parameter	typ.	max	Remarks
Power consumption	19 W*1	25 W*2	CL-2108
Connection terminals analog channels	4x safety banana jacks 4x Phoenix terminals		4 voltage channels 4 voltage channels for current probes
DSUB-15 DI, DO, INC, DAC channels	1x ACC/DSUB-DI4-8 1x ACC/DSUB-DO8 1x ACC/DSUB-ENC4 1x ACC/DSUB-DAC4		8 digital inputs 8 digital outputs 4 counter inputs 4 analog outputs
Connection terminals else 9-pin DSUB and 2-pin LEMO-plug	2 x DSUB-9 1 x DSUB-9 LEMO FGG.0B.302.CLAD62Z		two CAN-nodes Modem or GPS*3 supply
Weight	approx. 3,5 kg		without table-top power adapter
Dimensions (WxHxD) in mm	270 x 85 x 300		

*1 typical: UPS full recharged, no display, no flashcard, derating for 40°C (+15K)

*2 max.: with UPS recharging, with display, with flashcard, derating for 70°C (+15K)

*3 Only CL measurement systems ordered with GPS function are ex factory configured with a functional DSUB GPS plug.

The description of the CL-2108 85.

4.4.1 Cx-21xx analog inputs

Technical Data Sheet

Parameter	typ.	min. / max.	Remarks
Inputs	4 / 4		voltage, current
Measurement modes	voltage current		safety banana sockets Phoenix terminal
Measurement categories	600 V CAT III *		Maximum possible meas. category Pollution Degree 2

Sampling rate, Filter, Isolation strength			
Parameter	**typ.**	**min. / max.**	**Remarks**
Sampling rate / channel	≤100 kHz		
Filter cut-off frequency, characteristic, order	5 Hz to 10 kHz		 Butterworth, Bessel low pass filter: 8th Anti-aliasing filter: Cauer 8.order with f_{cutoff} = 0.4 f_s
Isolation strength		5.4 kV_{RMS}	50 Hz, 1 min test voltage

Channels for voltage measurement			
Parameter	**typ.**	**min. / max.**	**Remarks**
Input range	±1000 V, ±500 V, ±250 V, … , ±2.5 V		modulation range ≥ meas. range * √2
Max. Overvoltage strength		±1450 V	differential, continuous with operating temperature up to 70 °C
Input impedance	2.0 MΩ	±1%	
Input coupling	DC		isolated
Gain uncertainty	0.02 %	≤0.05 %	
Drift	±5 ppm/K·ΔT_a	±15 ppm/K·ΔT_a	range > ±100 V
	±8 ppm/K·ΔT_a	±20 ppm/K·ΔT_a	range ≤±100 V
	±12 ppm/K·ΔT_a	±30 ppm/K·ΔT_a	range ≤±5 V
			ΔT_a=|T_a -25°C|; ambient temp T_a
Offset	0.02 %	≤0.05 %	
	0.1 %		range ±5 V
	0.2 %		range ±2,5 V
Drift	±5 mV/K·ΔT_a	±15 mV/K·ΔT_a	range >±100 V
	±0.5 mV/K·ΔT_a	±2 mV/K·ΔT_a	range ≤±100 V
			ΔT_a=|T_a -25°C|; ambient temp T_a
Isolation suppression			Test voltage 500 V_{RMS}
		>130 dB	DC
		>70 dB	50 Hz
		>44 dB	1 kHz
Bandwidth	0 Hz to 6.5 kHz		<±0.1 %
		0 Hz to 14 kHz	-3 dB
Phase uncertainty		<±1°	0 Hz to 2.5 kHz
Signal noise			bandwidth: 0.1 Hz to 10 kHz
		<60 mV	range > ±100 V
		<6 mV	range ≤ ±100 V

Channels for current measurement with current probes			
Parameter	**typ.**	**min. / max.**	**Remarks**
Input range	±5 V, ±2.5 V, ±1 V, ... , ±250 mV		modulation range ≥ meas. range * √2
Overvoltage strength		±100 V	long-term
Input impedance	100 kΩ 500 kΩ	±1 % ±1 %	isolated up to ±1 V from ±2.5 V [1]
Isolation suppression			Isolation voltage: 500 V_{RMS}
		>130 dB	DC
		>105 dB	50 Hz
		> 80 dB	1 kHz
Measurement Bandwidth	0 Hz to 6.5 kHz	0 Hz to 14 kHz	<±0.1 % -3 dB
Phase uncertainty		<±1°	0 Hz to 2.5 kHz
Signal noise Noise suppression	75 µV	>84 dB	Bandwidth: 100 Hz

[1] For input voltages higher than 3 V the impedance is 83 kΩ.

Current measurement with MN71 clamp sensor			
Parameter	**typ.**	**min. / max.**	**Remarks**
Input range	10 $A_{\approx}$, 5 $A_{\approx}$, ... , 2.5 $A_{\approx}$		RMS-values, crest factor < 1.5
Overload strength		≤200 $A_{\approx}$	long-term, f ≤ 1 kHz, crest factor < 1.5
Measurement uncertainty	0.3 %	≤0.7 % ±1 mA	50 Hz, sine, line centered
Measurement Bandwidth		40 Hz to 6.5 kHz	<±0.5 %
Phase uncertainty		< ±3°	40 Hz to 1 kHz

Current measurement with AmpFlex A100 (2 kA)			
Parameter	**typ.**	**min. / max.**	**Remarks**
Input range	2000 $A_{\approx}$		RMS-values, crest factor <1.5
Overload strength		≤3000 $A_{\approx}$	long-term, f ≤ 1 kHz, crest factor < 1.5
Measurement uncertainty	0.2%	≤0.6% ±1 A	50 Hz, Sinus, line centered and orthogonal
Measurement Bandwidth		40 Hz to 6.5 kHz	<±0.6 %
Phase uncertainty		<±1°	40 Hz to 2.5 kHz

Current measurement with AmpFlex A100 (10 kA)			
Parameter	**typ.**	**min. / max.**	**Remarks**
Input range	with CRFX: 10 $kA_{\approx}$ with CRC, CRPL: 5 $kA_{\approx}$, 250 $A_{\approx}$		RMS-values, crest factor <1.5
Overload strength		≤10 $kA_{\approx}$	long-term, f ≤ 1 kHz, crest factor < 1.5
Measurement uncertainty	0.2%	≤0.6% ±2 A	50 Hz, sine, line centered and orthogonal
Measurement Bandwidth		40 Hz to 6.5 kHz	<±0.6 %
Phase uncertainty		<±1°	40 Hz to 2.5 kHz

The description of the CL-2108 85.

4.5 Cx-30xx analog inputs

Channels, measurement modes, terminal connection			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Inputs	8 16		CS CL
Measurement modes	voltage measurement transducer with constant current supply		e.g. ICP™-, DELTATRON®-Sensors [1]
Input coupling	DC AC, ICP		**AC-coupling** (or ICP) means a high pass filter at the input. To avoid drifting of the module, a high pass filter is always calculated, even if the user selects "without filter".
Terminal connection	BNC		

Sampling rate, Bandwidth, Filter, TEDS			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Sampling rate	≤100 kHz		per channel
Bandwidth	0 Hz to 48 kHz 0 Hz to 30 kHz		-3 dB -0.1 dB
Filter cut-off frequency characteristic order	10 Hz to 20 kHz		Butterworth, Bessel low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cutoff} = 0.4\ f_s$ for AC-coupling without filter a HP 2nd order Bessel with $f_{cutoff} = 1$ Hz (0.5 Hz with WAVE) is calculated
Filter cut-off frequency (high pass, 3th order,-3dB)	0.37 Hz 1.11 Hz	±5 % ±5 %	AC, ICP, range ≤ ±10 V AC, ICP, range > ±10 V
Resolution	16 Bit		internal processing 24 Bit
TEDS	conforming to IEEE 1451.4 Class I Mixed Mode Interface		TEDS-data and analog signal shared wire [2]

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input configuration	differential single-end		software-configurable
Voltage input ranges (IR)	±50 V, ±25 V, ±10 V, ±5 V, ±2.5 V, ±1 V, ..., ±5 mV		
Surge protection		±50 V	permanent channel to chassis
Input impedance Range > ±10 V ≤ ±10 V	 333 kΩ 0.67 MΩ 1 MΩ 908 kΩ 1.82 MΩ 20 MΩ		at DC-voltage resp. 50 Hz ICP (single-end) AC (differential) DC (differential) ICP (single-end) AC (differential) DC (differential)
Gain uncertainty	0.02 % +20 ppm/K·ΔT_a	≤0.05 % +80 ppm/K·ΔT_a	of display range (25°C) $\Delta T_a = \lvert T_a - 25°C \rvert$ ambient temperature T_a
Offset uncertainty drift	 0.02 % ±60 µV/K·ΔT_a ±0.06 µV/K·ΔT_a	 ≤0.05 % ≤0.06 % ±100 µV/K·ΔT_a ±0.3 µV/K·ΔT_a	of input range (25°C) > ±50 mV ≤ ±50 mV > ±10 V ≤ ±10 V $\Delta T_a = \lvert T_a - 25°C \rvert$ ambient temperature T_a
Common mode suppression Input ranges ±50 V to ±10 V ±5 V to ±50 mV ±25 mV to ±5 mV	 62 dB 92 dB 120 dB	 >46 dB >84 dB >100 dB	Common mode voltage (DC..60 Hz): ±50 V ±10 V ±10 V
Noise	0.4 µVrms 14 nV/√Hz		Bandwidth 0.1 kHz to 1 kHz

Constant current supply			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
ICP current sources	4.2 mA/channel	±10 %	
Compliance voltage	25 V	>24 V	
Source impedance	280 kΩ	>100 kΩ	

The description of the C-30xx-1. 95

[1] ICP is a registered trade mark of PCB Piezotronics Inc., Delta Tron is a registered trade mark of Bruel & Kjaer Sound and Vibration; PIEZOTRON, PIEZOBEAM is a registered trade mark of Kistler

[2] Only galvanically insulated sensors. For more detailed information, please refer to chapter "MMI-TEDS" in imc CRONOS manual.

4.6 Cx-41xx analog inputs

Technical Specs

Parameter	Value	Remarks
Analog inputs	8 24	CS CL
Measurement modes	voltage thermocouple, RTD (Pt100) current current fed sensors	 thermo plug (ACC/DSUB(M)-T4) shunt plug (ACC/DSUB(M)-I4) IEPE/ICP plug (ACC/DSUB-ICP4)
Terminal connection (DSUB-15) analog inputs	ACC/DSUB(M)-U4 ACC/DSUB(M)-I4 ACC/DSUB-ICP4	

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz	per channel
Bandwidth	0 Hz to 11 kHz 0 Hz to 8 kHz	-3 dB -0.2 dB
Filter (digital) cut-off frequency characteristic order	2 Hz to 5 kHz	 Butterworth, Bessel low pass filter: 8th order high pass filter: 4th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cut\text{-}off} = 0.4\ f_a$
Resolution	16 Bit	internal processing 24 Bit
TEDS - Transducer Electronic DataSheets	conforming to IEEE 1451.4 Class II MMI	ACC/DSUB(M)-TEDS-xx

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Isolation	galvanically isolated		channel to case (housing, CHASSIS, PE) and channel-to-channel not with IEPE/ICP plug
nominal rating	±60 V		channel to case
test voltage	±300 V (10 sec.)		
Overvoltage protection	±60 V ESD 2 kV transient protection: automotive load dump ISO 7637, Test impulse 6		differential input voltage (continuous) human body model test pulse 6 with max. -250 V R_i=30 Ω, t_d=300 µs, t_r<60 µs
Input coupling	DC		
Input configuration	differential, isolated		galvanically isolated to System-GND (case, CHASSIS)
Input impedance	10 MΩ 1 MΩ 50 Ω		range ≤±2 V and temperature mode range ≥±5 V or device powered down with shunt plug ACC/DSUB(M)-I4
Input current operating conditions on overvoltage condition		 1 nA 1 mA	for operation $\|V_{in}\|$ > 5 V on ranges <±5 V or device powered-down
Auxiliary supply voltage available current internal resistance	 +5 V >0.26 A 1.0 Ω	 ±5% >0.2 A <1.2 Ω	for IEPE/ICP plug independent of optional sensor supply, short circuit proof power per DSUB-plug

Voltage measurement				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Voltage input ranges	±60 V / ±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V / ±500 mV ±200 mV / ±100 mV / ±50 mV			
Gain uncertainty	<0.025%	<0.05%	of the measured value, at 25°C	
Gain drift		6 ppm/K ·ΔT_a 50 ppm/K ·ΔT_a	ranges ≤±2 V ranges ≥±5 V	over full temp. range
Offset uncertainty	0.02%	<0.05%	of the range	
Offset drift		2.5 ppm/K ·ΔT_a	over entire temperature range	
Non-linearity	<120 ppm			
Input voltage noise	2.5 μV_{rms} 20 μV_{pkpk}		bandwidth 0.1 Hz to 1 kHz; in the range:±50 mV	
CMRR (common mode rejection ratio) / IMR	>145 dB (50 Hz) >70 dB (50 Hz)		range ≤±2 V range ≥±5 V	R_{source} = 0 Ω
Channel isolation	>1 GΩ, < 40 pF		channel-to-ground / CHASSIS (case)	
	>1 GΩ, <10 pF		channel-to-channel	
Channel isolation (crosstalk)	> 165 dB (50 Hz) > 92 dB (50 Hz)		range ≤ ±2 V range ≥ ±5 V	R_{source} ≤ 100 Ω

Current measurement with shunt plug				
Parameter	**Value typ.**	**min. / max.**	**Remarks**	
Current input ranges	±40 mA / ±20 mA / ±10 mA ±5 mA / ±2 mA / ±1 mA			
Shunt impedance	50 Ω			
Gain uncertainty	<0.07%	<0.15%	of the measured value, with 25°C	
Gain drift		6 ppm/K 50 ppm/K	ranges ≤± 2 V ranges ≥± 5 V	over full temp. range
Offset uncertainty	0.02%	<0.05%	of the measurement range	
Offset drift		2.5 ppm/K $\cdot\Delta T_a$	over entire temperature range	

Temperature measurement - thermocouples			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Measurement range	R, S, B, J, T, E, K, L, N		according IEC 584
Resolution	0.063 K (1/16 K)		
Measurement uncertainty		< ±0,6 K < ±1.0 K < ±1.5 K	type K, range -150 °C to 1200 °C type T, range -150 °C to 400 °C type N, range 380 °C to 1200 °C type K, range -200 °C to -150 °C type T, range -200 °C to -150 °C type N, range -200 °C to 380 °C
Temperature drift	±0.02 K/K $\cdot\Delta T_a$		$\Delta T_a = \lvert T_a - 25\ °C \rvert$ ambient temperature T_a
Uncertainty of cold junction compensation Temperature drift	 ±0.001 K/K $\cdot\Delta T_j$	< ±0.15 K	with ACC/DSUB-T4 $\Delta T_j = \lvert T_j - 25°C \rvert$ cold junction temperature T_j

Temperature measurement – PT100			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Measurement range	-200 °C to +850 °C -200 °C to +250 °C		
Resolution	0.063 K (1/16 K)		
Measurement uncertainty	<±0.2 K <±0.05 %		4-wire connection -200 °C to +850 °C plus of reading
Temperature drift	±0.01 K/K ΔT_a		$\Delta T_a = \lvert T_a - 25\ °C \rvert$; ambient temp. T_a
Sensor feed (PT100)	250 µA		non-isolated

The description of the CS-4108 [-N], CL-4124 [-N]

4.7 Cx-50xx analog inputs

Parameter	Value	Remarks
Inputs	8 16	CS CL
Measurement modes	bridge-sensor bridge: strain gauge voltage measurement current measurement charge current feed sensors (IEPE/ICP)	ACC/DSUB(M)-UNI2 (for all modes) ACC/DSUB(M)-I2 shunt-plug or single ended (internal shunt) ACC/DSUB-Q2 ACC/DSUB-ICP2 (ICP™-, Deltatron®-, Piezotron®-Sensors)
Terminal connection analog inputs	ACC/DSUB(M)-B2 ACC/DSUB(M)-I2 ACC/DSUB-ICP2	

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz	per channel
Bandwidth	0 Hz to 5 kHz	-3 dB
Filter (digital) cut-off frequency characteristic order	1 Hz to 2 kHz	 Butterworth, Bessel (digital) low pass or high pass filter 8th order band pass, LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cutoff} = 0.4\ f_s$
Resolution	16 Bit	internal processing 24 Bit
TEDS	conforming to IEEE 1451.4 Class II MMI	ACC/DSUB(M)-TEDS-xx

General			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Overvoltage protection		±40 V	permanent
Input coupling	DC		
Input configuration	differential		
Input impedance	20 MΩ	±1%	differential

Sensor supply 5 V (DSUB-15)			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Auxiliary supply voltage available current internal resistance	 +5 V >0.26 A 1.0 Ω	 ±5% >0.2 A <1.2 Ω	for IEPE (ICP)-extension plug independent of integrated sensor supply, short circuit proof power per DSUB-plug

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±10 V, ±5 V, ±2.5 V, ±1 V... ±5 mV		
Gain uncertainty	0.02 % +10 ppm/K·ΔT_a	≤0.05 % +30 ppm/K·ΔT_a	of the measured value, at 25°C´ ΔT_a=|T_a -25°C|; ambient temp: T_a
Gain drift			
Offset uncertainty drift	 0.02 % ±0.7 µV/K·ΔT_a ±0.1 µV/K·ΔT_a	 ≤0.05 % ≤0.06 % ±6 µV/K·ΔT_a ±1.1 µV/K·ΔT_a	of range, in ranges (25°C) >±50 mV ≤±50 mV ±10 V to ±0.25 V ≤±0.1 V ΔT_a=|T_a -25 °C| ambient temp T_a
Non-linearity	10 ppm	≤50 ppm	
Common mode rejection ranges: ±10 V to ±50 mV ±25 mV to ±5 mV	 >110 dB >138 dB	 >90 dB >132 dB	Common mode voltage (DC..60 Hz): test voltage: ±10 V=
Noise (RTI)	 0.6 µVeff 0.14 µVeff	 1.0 µVeff 0.26 µVeff	bandwidth 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Measurement modes	full bridge half bridge quarter bridge		1 V / 5 V / 10 V 1 V / 5 V / 10 V 1 V / 5 V
Input ranges			
bridge supply: 10 V	±1000 mV/V, ±500 mV/V, ±200 mV/V, ±100 mV/V ... ±0.5 mV/V		
bridge supply: 5 V	±1000 mV/V, ±500 mV/V, ±200 mV/V, ±100 mV/V ... ±1 mV/V		all modes
bridge supply: 2.5 V as an option	±1000 mV/V, ±500 mV/V, ±200 mV/V, ±100 mV/V ... ±2 mV/V		consider remarks: bridge excitation voltage
bridge supply: 1 V as an option	±1000 mV/V, ±500 mV/V, ±250 mV/V, ±100 mV/V ... ±5 mV/V		
Input impedance	20 MΩ	±1 %	differential, full bridge
Gain uncertainty	0.02 %	≤0.05 %	of reading
Offset uncertainty	0.01 %	≤0.02 %	of input range after automatic bridge balancing
Bridge excitation voltage (optional)	10 V 5 V (2.5 V)	±0.5 %	 standard ranges with 2.5 V: +2.5 V, +5.0 V, +10 V, +12 V, +24 V
Min. bridge impedance	120 Ω, 10 mH full bridge 60 Ω, 10 mH half bridge		

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Max. bridge impedance	5 kΩ		
Internal quarter bridge completion	120 Ω, 350 Ω		internal, switched per software
automatic shunt calibration	0.5 mV/V	± 0.2 %	for 120 Ω and 350 Ω
Cable resistance for bridges (without return line)	< 6 Ω < 12 Ω		10 V excitation 120 Ω 5 V excitation 120 Ω

Current measurement			
Parameter	**Value typ.**	**min. / max**	**Remarks**
Input ranges	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±1 mA		with 50 Ω shunt in terminal plug ACC/DSUB-I2 or with 120 Ω internally
Over load protection		±60 mA	permanent
Input configuration	single-end differentiell		with 120 Ω internally or 50 Ω shunt in terminal plug (ACC/DSUB-I2)
Gain: uncertainty drift	0.02 % +15 ppm/K·ΔT_a	≤ 0,06 % ≤ 0,1 % +55 ppm/K·ΔT_a	of reading plus uncertainty of 50 Ω shunt
Offset: uncertainty	0.02 %	≤ 0,05 %	of range

Noise (current)	0.6 nA_{eff} 0.15 nA_{eff}	10 nA_{eff} 0.25 nA_{eff}	bandwidth: 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz

Sensor supply ±VB				
Parameter	**Value**			**Remarks**
Configuration options	5 ranges			The sensor supply module always got 5 selectable voltage ranges. Default ranges: +5 V to +24 V
Output voltage	Voltage	Current	Power	set jointly for all eight channels
	(+2.5 V)	580 mA	1.5 W	optional, special order: +12 V or +15 V can be replaced by +2.5 V
	+5.0 V	580 mA	2.9 W	standard ranges with 2.5 V:
	+10 V	300 mA	3.0 W	+2.5 V, +5.0 V, +10 V, +12 V, +24 V
	+12 V	250 mA	3.0 W	
	+15 V	200 mA	3.0 W	
	+24 V	120 mA	2.9 W	
	(±15 V)	190 mA	3.0 W	optional, special order: +15 V can be replaced by ±15 V
Isolation	non isolated			output to case (CHASSIS)
Short-circuit protection	unlimited duration			to reference ground of output voltage
Accuracy of output voltage	<0.25 % (typ.) / <0.5 % (max.) <0.9 % (max).			at terminals, no load at 25°C over entire temp. range
compensation of cable resistances	3-wire adjustment: SENSE line on return line (–VB: supply ground			Calculated compensation for bridges (no voltage adjustment) Prerequisites: symmetric feed and return lines
Max. capacitive load	>4000 µF >1000 µF >300 µF			2.5 V to 10 V 12 V, 15 V 24 V

The description of the CS-5008-1 [-N], CL-5016-1 [-N], CX-5032-1 [-N]. 102

4.8 Cx-60xx analog inputs

Parameter	Value	Remarks
Inputs	4 12	CS CL
Measurement modes with DSUB	full bridge half bridge quarter bridge LVDT voltage current current-fed sensors IEPE/ICP	Voltage or bridge mode global for all four channels. inductive transducers (CF) with ACC/DSUB(M)-I2 ACC/DSUB-ICP2
Terminal connection	DSUB-15	ACC/DSUB(M)-B2 ACC/DSUB(M)-I2 ACC/DSUB-ICP2

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	20 kHz (max)	per channel
Bandwidth	8.6 kHz (DC) 3.9 kHz (CF)	-3 dB
Filter cut-off frequency characteristic order	2 Hz to 5 kHz	Butterworth, Bessel low pass filter 8. order Anti-aliasing filter: Cauer 8. order with $f_{cutoff} = 0.4\ f_s$
Resolution	16 Bit	internal processing 24 Bit
TEDS - Transducer Electronic DataSheets	conforming to IEEE 1451.4 Class II MMI	ACC/DSUB(M)-TEDS-xx

General			
Parameter	**Value typ.**	**min. / max**	**Remarks**
Overvoltage protection		±50 V ±80 V	long term (differential- and SENSE-inputs) short-term
Input impedance	10 MΩ 1 MΩ		range ±5 mV to ±2 V range ±5 V to ±50 V and for deactivated device
Input current		40 nA	
Input capacitance	300 pF		
Auxiliary supply voltage available current internal resistance	 +5 V >0.26 A 1.0 Ω	 ±5% >0.2 A <1.2 Ω	for IEPE (ICP)-extension plug independent of integrated sensor supply, short circuit proof power per DSUB-plug

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input ranges	±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V ±500 mV / ±250 mV / ±100 mV ±50 mV / ±25 mV / ±10 mV / ±5 mV		
Gain uncertainty	0.02 %	≤0.05 %	of reading (measurement value)
Gain drift	60 ppm / K	<100 ppm / K	
Offset drift	0.02%	≤0.05% ≤0.1% ≤0.2%	of measurement range range ≥ ±25 mV range = ±10 mV range = ±5 mV
Input offset-drift	0.05 µV / K	0.3 µV / K	DC voltage measurement
Non-linearity	<200 ppm		
Common mode voltage (max.)	±50 V ±2,8 V		ranges ±50 V to ±5 V ranges ±2 V bis ±5 mV
Common mode rejection ratio (CMRR)			
range ±5 mV to ±25 mV range ±50 mV to ±100 mV range ±250 mV to ±2 V range ±5 V to ±50 V		>120 dB >110 dB 95 dB >54 dB	DC
range ±5 mV to ±2 V range ±5 V to ±50 V	>100 dB >68 dB	>90 dB >54 dB	f ≤ 50 Hz
all ranges		>50 dB	f = 5 kHz
SNR (signal to noise ratio)	>90 dB >88 dB >82 dB >75 dB >69 dB		full-scale / rms-noise full bandwidth ranges ±100 mV to ±50 V range ±50 mV range ±25 mV range ±10 mV range ±5 mV
Input noise, voltage (RTI)	16 nV/√Hz rms 16 µV pk-pk 2 µV rms 0.6 µV pk-pk		DC-Mode (range ±5 mV) spectral noise density 1 kHz 0 Hz to 10 kHz 0 Hz to 10 kHz 0.1 Hz to 10 Hz

Current measurement with shunt plug		
Parameter	**Value**	**Remarks**
Input ranges	±40 mA / ±20 mA / ±10 mA ±5 mA / ±2 mA / ±1 mA ±400 µA / ±200 µA / ±100 µA	
Shunt impedance	50 Ω	shunt plug ACC/DSUB(M)-I2

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Mode	DC, CF		
Sensors	LVDT, strain gauge: full-, half-, quarter bridge piezo-resistive bridge transducer potentiometer		directly connectable
Bridge measurement mode	full-, half-, quarter bridge		
Bridge input ranges	±1 mV/V to ±400 mV/V ±2 mV/V to ±800 mV/V ±5 mV/V to ±2000 mV/V		for bridge voltage: 5 V 2.5 V 1 V
Bridge voltage DC CF (5 kHz)	1 V; 2.5 V; 5 V (symmetric) 1 V; 2.5 V; 5 V (peak)		set globally for 4-channel groups corresponding to ±0.5 V, ±1.25 V, ±2.5 V corresponding to RMS: 0.7 V; 1.8 V; 3.5 V
Internal quarter-bridge completion	120 Ω, 350 Ω		selectable
Min. bridge impedance Bridge impedance (max.)	120 Ω, 10 mH full bridge 60 Ω, 5 mH half bridge 5 kΩ		bridge supply = 1 V to 5 V, $I_{load} \leq 42$ mA
Gain uncertainty	<0.05%		of measurement value at 25°C
Offset after bridge balance	<0.02%		of the range at 25°C
Input offset-drift	0.01 µV/V / K	0.06 µV/V / K	DC full bridge (Vb=5 V, 1 mV/V range) without ext. bridge offset
Drift of bridge balance Equivalent offset drift corresponding to balanced ext. bridge offset	50 ppm/K 0.05 µV/V/K	<90 ppm/K 0.09 µV/V/K	of compensated offset value full bridge (DC or CF), ext. bridge offset = 1 mV/V 1 mV/V input range
Half-bridge drift (int. half-bridge)	0.05 µV/V/K	1 µV/V/K	DC or CF
Bridge balancing range	≥ measurement range not less than: ≥±5 mV/V ≥±10 mV/V ≥±25 mV/V		 for bridge supply = 5 V for bridge supply = 2.5 V for bridge supply = 1 V
Cable length (max.)	500 m (one-way length)		A = 0.14 mm², R = 130 mΩ/m, 65 Ω
Lead wire compensation technique	3 schemes available: double Sense simple Sense by means of shunt-calibration		(half-/full bridge) any cables; for symmetric cables of same type; one-time compensation (not continuously adapted)

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Automatic shunt-calibration	0.5 mV/V		for 120 Ω and 350 Ω bridges
Input noise (bridge)			range: 1 µV/V (bridge voltage = 5 V)
DC full bridge	3 $\mu V/V_{pkpk}$, 0.39 $\mu V/V_{rms}$		0 Hz to 10 kHz
	0.9 $\mu V/V_{pkpk}$, 0.12 $\mu V/V_{rms}$		1 kHz, lowpass filter
	0.3 $\mu V/V_{pkpk}$, 0.04 $\mu V/V_{rms}$		100 Hz, lowpass filter
	0.1 $\mu V/V_{pkpk}$		10 Hz, lowpass filter
DC half-/quarter bridge	3.3 $\mu V/V_{pkpk}$, 0.45 $\mu V/V_{rms}$		0 Hz to 10 kHz
	1.1 $\mu V/V_{pkpk}$, 0.15 $\mu V/V_{rms}$		1 kHz, lowpass filter
	0.35 $\mu V/V_{pkpk}$, 0.05 $\mu V/V_{rms}$		100 Hz, lowpass filter
	0.3 $\mu V/V_{pkpk}$		10 Hz, lowpass filter
CF full bridge, half bridge	3.5 $\mu V/V_{pkpk}$, 0.47 $\mu V/V_{rms}$		0 Hz to 10 kHz
	1.7 $\mu V/V_{pkpk}$, 0.22 $\mu V/V_{rms}$		1 kHz, lowpass filter
	0.6 $\mu V/V_{pkpk}$, 0.07 $\mu V/V_{rms}$		100 Hz, lowpass filter
	0.3 $\mu V/V_{pkpk}$		10 Hz, lowpass filter

Find here the description of the CS-6004-1 [-N], CL-6012-1 [-N].

4.9 Cx-70xx analog inputs

Channels, measurement modes, terminal connection		
Parameter	**Value**	**Remarks**
Inputs	8 16	CS CL
Measurement modes	bridge-sensor bridge: strain gauge voltage thermocouples Pt100 (3- and 4-wire configuration) current current fed sensors (IEPE/ICP) charge	ACC/DSUB(M)-UNI2 (for all modes) ACC/DSUB(M)-I2 shunt-plug or single ended (internal shunt) ACC/DSUB-ICP2, ACC/DSUB-ICP-BNC (ICP™-, Deltatron®-, Piezotron®-Sensors) ACC/DSUB-Q2
Terminal connection analog inputs	ACC/DSUB(M)-UNI2 ACC/DSUB(M)-I2 ACC/DSUB-ICP2	

Sampling rate, Bandwidth, Filter, TEDS		
Parameter	**Value**	**Remarks**
Sampling rate	≤100 kHz	per channel
Bandwidth	0 Hz to 48 kHz 0 Hz to 30 kHz 0 Hz to 10 Hz	-3 dB -0.1 dB -3 dB for temperature measurement
Filter (digital) cut-off frequency characteristic order	10 Hz to 20 kHz	 Butterworth, Bessel low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with $f_{cutoff} = 0.4\ f_s$
Resolution	16 Bit	internal processing 24 Bit
TEDS Transducer Electronic Data Sheets	conforming to IEEE 1451.4 Class II MMI	ACC/DSUB(M)-TEDS-xxx

General			
Parameter	**Value typ.**	**min. / max**	**Remarks**
Overvoltage protection		±80 V ±50 V	permanent, differential >±10 V and device off ≤±10 V
Input coupling	DC		
Input configuration	differential		
Input impedance	1 MΩ 20 MΩ	±1%	input range >±10 V input range ≤±10 V
Auxiliary supply voltage available current internal resistance	 +5 V >0.26 A 1.0 Ω	 ±5% >0.2 A <1.2 Ω	for IEPE (ICP)-extension plug independent of integrated sensor supply, short circuit proof power per DSUB-plug

Voltage measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Voltage input range	±50 V, ±25 V, ±10 V, ±5 V, ±2.5 V, ±1 V... ±5 mV		
Gain uncertainty	0.02%	≤0.05%	of the measured value, at 25°C
Gain drift	+10 ppm/K·ΔT_a	+30 ppm/K·ΔT_a	ΔT_a=|T_a-25°C| ambient temperature T_a
Offset uncertainty	0.02%	 ≤0.05% ≤0.06%	of the range, at 25°C range >±50 mV range ≤±50 mV
Offset drift	±40 µV/K·ΔT_a ±0.7 µV/K·ΔT_a ±0.1 µV/K·ΔT_a	±200 µV/K·ΔT_a ±6 µV/K·ΔT_a ±1.1 µV/K·ΔT_a	range >±10 V ±10 V to ±0.25 V ≤±0.1 V ΔT_a=|T_a–25°C| ambient temperature T_a
Nonlinearity	30 ppm	≤90 ppm	
CMRR (common mode rejection ratio) / IMR range ±50 V to ±25 V ±10 V to ±50 mV ±25 mV to ±5 mV	 80 dB 110 dB 138 dB	 >70 dB >90 dB >132 dB	test voltage (DC and f≤60 Hz) ±50 V ±10 V ±10 V
Noise	3.6 μV_{eff} 0.6 μV_{eff} 0.14 μV_{eff}	5.5 μV_{eff} 1.0 μV_{eff} 0.26 μV_{eff}	range 0.1 Hz to 50 kHz range 0.1 Hz to 1 kHz range 0.1 Hz to 10 Hz

Current measurement with shunt plug			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Current input range	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±1 mA		
Shunt impedance	50 Ω		external plug ACC/DSUB(M)-I2
Over load protection		±60 mA	long term
Input configuration	differential		isolated
Gain uncertainty	0.02%	≤0.06% ≤0.1%	of the reading, at 25°C plus uncertainty of 50 Ω in plug
Gain drift	15 ppm/K·ΔT_a	55 ppm/K·ΔT_a	ΔT_a=|T_a-25°C| ambient temperature T_a
Offset uncertainty	0.02%	≤0.05%	of the range, at 25°C
Noise current	 40 nA_{eff} 0.7 nA_{eff} 0.17 nA_{eff}	 70 nA_{eff} 12 nA_{eff} 0.3 nA_{eff}	Bandwidth: 0.1 Hz to 50 kHz 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz

Current measurement with internal shunt plug			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Current input range	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±1 mA		
Shunt impedance	120 Ω		internal
Over load protection		±60 mA	long term
Input configuration	single-end		not isolated
Gain uncertainty	0.02%	≤0.06%	of the reading, at 25°C
Gain drift	15 ppm/K·ΔT_a	55 ppm/K·ΔT_a	ΔT_a=|T_a-25°C| ambient temperature T_a
Offset uncertainty	0.02%	≤0.05%	of the range, at 25°C
Noise current	 40 nA_{eff} 0.7 nA_{eff} 0.17 nA_{eff}	 70 nA_{eff} 12 nA_{eff} 0.3 nA_{eff}	Bandwidth: 0.1 Hz to 50 kHz 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz

Bridge measurement			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Mode	DC		
Bridge measurement modes	full bridge half bridge quarter bridge		 ≤5 V bridge supply only
Bridge supply	2.5 V to 10 V	±0,5%	standard ranges with 2.5 V: +2.5 V, +5.0 V, +10 V, +12 V and +24 V
Minimum bridge impedance Maximum bridge impedance	120 Ω full bridge 60 Ω half bridge 5 kΩ		
Quarter bridge completion	120 Ω, 350 Ω		internal, switched per software
Automatic shunt-calibration (calibration jump)	0.5 mV/V	±0.2%	for 120 Ω and 350 Ω
Bridge input range			
bridge supply: 10 V	±1000 mV/V, ±500 mV/V, ±200 mV/V, ±100 mV/V ... ±0.5 mV/V		
bridge supply: 5 V	±1000 mV/V, ±500 mV/V, ±200 mV/V, ±100 mV/V ... ±1 mV/V		all modes
bridge supply: (2.5 V) (as an option)	±1000 mV/V, ±500 mV/V, ±200 mV/V, ±100 mV/V ... ±2 mV/V		consider remarks of the bridge excitation voltage
Input impedance	20 MΩ	±1%	differential, full bridge
Gain uncertainty	0.02%	≤0.05%	of the reading, at 25°C
Gain drift	20 ppm/K·ΔT_a	50 ppm/K·ΔT_a	ΔT_a=|T_a–25°C| ambient temperature T_a
Offset uncertainty	0.01%	≤0.02%	of input range after automatic bridge balancing

Temperature measurement - Thermocouples			
Parameter	**Value typ.**	**min./ max.**	**Remarks**
Measurement mode	J, T, K, E, N, S, R, B		according IEC 584
Measurement range	-270°C bis 1370°C -270°C bis 1100°C -270°C bis 500°C		type K
Resolution	0.063 K (1/16 K)		
Measurement uncertainty (gain + offset)		 ≤0.05% ≤0.05%	type K of measurement range (25°C) of reading
Drift (gain + offset)	+0.02 K/K·ΔT_a	+0.05 K/K·ΔT_a	ΔT_a=|T_a-25°C| ambient temperature T_a
Uncertainty of cold junction compensation		<±0.15 K	with ACC/DSUB-UNI2 at 25°C
Cold junction drift	±0.001 K/K·ΔT_a		ΔT_a=|T_a-25°C| ambient temperature T_a

Temperature measurement - PT100			
Parameter	**Value typ.**	**min. / max.**	**Remarks**
Input range	-200°C to 850°C -200°C to 250°C		resolution: approx. 0.1 K approx. 0.1 K
Resolution	0.063 K (1/16 K)		
Measurement uncertainty (gain + offset)		<±0.25 K +0.02% <±0.1 K +0.02%	4-wire measurement: -200°C to 850°C of reading -200°C to 250°C of reading
Drift (gain + offset)		+0.01 K/K·ΔT_a	$\Delta T_a = \lvert T_a - 25°C \rvert$ ambient temperature T_a
Sensor feed (PT100)	1.23 mA		

Sensor supply ±VB				
Parameter	**Value**			**Remarks**
Configuration options	5 selectable ranges			The sensor supply module always got 5 selectable voltage ranges. Default ranges: +5 V to +24 V
Output voltage	Voltage (+2.5 V) +5.0 V +10 V +12 V +15 V +24 V (±15 V)	Current 580 mA 580 mA 300 mA 250 mA 200 mA 120 mA 190 mA	Power 1.5 W 2.9 W 3.0 W 3.0 W 3.0 W 2.9 W 3.0 W	set jointly for all eight channels optional, special order: +12 V or +15 V can be replaced by +2.5 V default ranges with 2.5 V: +2.5 V, +5.0 V, +10 V, +12 V, +24 V optional, special order: +15 V can be replaced by ±15 V
Isolation	non isolated			output to case (CHASSIS)
Short-circuit protection	unlimited duration			to output voltage reference ground
Accuracy of output voltage	<0.25 % (typ.) / <0.5 % (max.) <0.9 % (max).			at terminals, no load 25°C over entire temperature range
Compensation of cable resistances	3-line control: SENSE line as refeed (–VB: supply ground)			Calculated compensation for bridges (no voltage adjustment) Prerequisites: symmetric feed and return lines
Max. capacitive load	>4000 µF >1000 µF >300 µF			2.5 V .. 10 V 12 V, 15 V 24 V

Find here the description of the CS-7008-1 [-N], CL-7016-1 [-N]. 119

4.10 CS-8008 general technical data

Technical data sheet Version 1.4

Parameter	typ.	max	Remarks
Power consumption	25 W*1	31 W*2	CS-8008
Connection terminals analog channels	8x BNC		8 channels for voltage or current feed sensors
15-pin DSUB terminal plugs DI, DO, INC, DAC channels 15 pin DSUB	1x ACC/DSUB-DI4-8 1x ACC/DSUB-DO8 1x ACC/DSUB-ENC4 1x ACC/DSUB-DAC4		8 digital inputs 8 digital outputs 4 counter inputs 4 analog outputs
Connection terminals else 9-pin DSUB and 2-pin LEMO-plug	2x DSUB-9 1x DSUB-9 1x DSUB-9 LEMO FGG.1B.302.CLAD62Z		two CAN-nodes Display (CS) Modem or GPS supply
Weight without table-top power adapter	approx. 2 kg		CS-8008
Dimensions (WxHxD) in mm	132 x 111 x 185		CS-8008

*1 typical: UPS full recharged, no display, no flashcard, derating for 40°C (+15K)

*2 max.: with UPS recharging, with display, with flashcard, derating for 70°C (+15K)

The description of the CS-8008. 134

4.10.1 C-80xx analog inputs

Parameter	typ.	min. / max.	Remarks
Inputs	8		8x BNC; differential, analog
Measurement modes	voltage current feed sensors		

Bandwidth, Filter, TEDS			
Parameter	**typ.**	**min. / max.**	**Remarks**
Filter (digital) cut-off frequency, characteristic, order	10 kHz, 5 kHz to 5 Hz		Butterworth, Bessel low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with f_{cutoff} = 0.4 f_s for AC-coupling without filter a HP 2nd order Bessel with f_{cutoff} = 1 Hz (0.5 Hz with WAVE) is calculated
Thirds octave processing	optional (4 channels + 4 virtual channels)		for further processing Online FAMOS or imc WAVE is necessary
Sampling rate / channel	≤100 kHz ≤50 kHz		**without** third octave processing **with** third octave processing
Bandwidth (AC)	1 Hz 45.3 kHz 48.6 kHz 54.7 kHz 22.4 kHz		-3 dB lower cut-off frequency ±0.005 dB without third octave process. -3 dB -112 dB -3 dB with third octave processing
TEDS sensors (current supply)	conform IEEE 1451.4 Class I MMI		

Voltage			
Parameter	**typ.**	**min. / max.**	**Remarks**
Ranges	±50 V, ±25 V, ±10 V, ±5 V, ±2.5 V, ±1 V... ±25 mV		
Input voltage surge protection		±65 V ±200 V	refer to chassis continuous <2 ms [1]
Input impedance	 1 MΩ 10 MΩ 2 MΩ 20 MΩ	 ±1% ±2% ±1% ±2%	single-end, ranges: ±50 V, ±25 V ±10 V to ±25 mV differential, ranges: ±50 V, ±25 V ±10 V to ±25 mV
Input coupling	DC AC, ICP		HP, 3th order,-3dB fc=1.24 Hz (Standard) fc=0.86 Hz (imc WAVE)
Input configuration	differential, single end		
Gain uncertainty drift	 0.004 % 0.006 % ±36 ppm/K·ΔT_a	 ≤0.05 % ≤0.1 % ±110 ppm/K·ΔT_a	of reading, ranges: ±50 V to ±50 mV ±25 mV $\Delta T_a = \lvert T_a - 25\ °C \rvert$ ambient temperature T_a

Voltage			
Parameter	**typ.**	**min. / max.**	**Remarks**
Offset uncertainty (DC)			of measurement range, ranges:
	0.004 %	≤0.03 %	±50 V to ±250 mV
	0.005 %	≤0.05 %	±100 mV
	0.006 %	≤0.10 %	±50 mV
	0.006 %	≤0.15 %	±25 mV
drift	±170 µV/K·ΔT_a	±610 µV/K·ΔT_a	range >±10 V
	±6.5 µV/K·ΔT_a	±90 µV/K·ΔT_a	range ≤±10 V
			ΔT_a=|T_a –25 °C|
			ambient temperature T_a
Offset uncertainty (AC, ICP)		2 LSB	
Max. settling time of the 1 Hz Input high pass filter (AC)		20 s	
Common mode voltage			ranges:
		±65 V	±50 V, ±25 V
		±10 V	±10 V to ±25 mV
Common mode suppression CMRR			coupling DC, common mode test voltage ±10 $V_=$ or 4 V_{rms}; ranges:
	68 dB	>60 dB	±50 V, ±25 V
	82 dB	>66 dB	±10 V to ±5 V
	95 dB	>78 dB	±2.5 V to ±1 V
	101 dB	>84 dB	±500 mV
	108 dB	>96 dB	±250 mV to ±25 mV
Signal to noise ratio			(A-weighted), ≤100 ksps bandwidth 20 Hz to 20 kHz
	-110 dB	-90 dB	±50 V to ±0.25 V
	-90 dB		±100 mV
	-84 dB		± 50 mV
	-78 dB		± 25 mV
Noise voltage (rms)			bandwidth 10 Hz to 10 kHz
	1.4 µV		±0.25 V

[1] For voltages greater than the maximum voltage of the chosen range and lower than 70 V, you may get a 5 mA input current. Above 70 V you can expect higher currents which can only be handled for 2 ms.

ICP™-, DELTATRON®-Sensors			
Parameter	**typ.**	**min. / max.**	**Remarks**
Constant current	4.2 mA	±10 %	
Compliance voltage	25 V	>24 V	
Source impedance	280 kΩ	>100 kΩ	

Find here the description of the CS-8008. 134

4.11 Technical Specs: Features (for all devices of imc C-SERIES)

4.11.1 Variants

The following overview display expansions of Cx-**N** from the former Cx variant

	CS	CS-N	CL	CL-N	CX
General					
Aggregate sampling rate	400 kSps				
Housing type	extruded alu profile		flat portable plastic		desktop
Weight	1,8 kg	1,8 kg	3,5 kg	3,5 kg	7,0 kg
Operating conditions					
Standard operating temp. range	●	●	●	●	●
Extended temp. range (incl. condensation)	o	o	o	o	o
Shock and vibration rating	30g pk (3 ms)				
Connectivity					
Ethernet	●	●	●	●	●
W-LAN (WiFi) external (CF adaptor)	(o) (1)		(o) (1)		(o) (1)
W-LAN (WiFi) internal		o		o	o
Modem connection port	●				●
Modem internal (RJ45)			o		
GPS connection port	(o)	●	o	●	●
Display connection port	●	●			●
Display integrated			●	●	
Remote controlled main switch			●	●	●
Synchronization signal	BNC	BNC	SMB	BNC	BNC
Isolated SYNC signal		●		●	
Programmable status feedback (LEDs)	●	●			●
Data Storage					
PCMCIA slot + CF card adaptor	●		●		
CF card slot (Compact Flash)		●		●	●
storage on PC	●	●	●	●	●
storage on network drive		●		●	●
hard disk (internal)			o	o	o
Stand Alone Capabilities					
PC independent complex trigger functionality	●	●	●	●	●
onboard real-time data analysis (imc Online FAMOS)	●	●	●	●	●
Autarkic PC-less operation, self start (timer, absolute time)	●	●	●	●	●
Synchronization & Clock					
Master-Slave between different imc systems	●	●	●	●	●
NTP network based synchronization		●		●	
via external GPS signal	(o)	●	●	●	●
via external DCF-77 signal	●	●	●	●	●
via external IRIG-B & DCF-77 signal		●		●	
system clock tracking with "catch up"		●		●	●
Field Bus Extension					
CAN (2 nodes)	●	●	●	●	●
Pulse Counter and Process Control (Digital I/O, Analog Out)					
8 Bit digital in, 8 Bit digital out	●	●	●	●	●
4 pulse counter (2 chan quadrature mode)	●	●	●	●	●
4 channel analog out (DAC)	●	●	●	●	●
Power Supply					
DC input 10V to 32V	●	●	●	●	●
AC/DC adaptor (110 to 230VAC)	●	●	●	●	●
data integrity upon power fail	●	●	●	●	●
UPS	●	●	●	●	●
automatic shutdown after power failure	1 s	1 s	30 s	30 s	30 s
isolated power supply input			●	●	●
Software					
imc STUDIO Standard included	●	●	●	●	●
imc REMOTE WebServer		o		o	o

(1) no longer available

4.11.2 Digital Inputs

Technical Details

Parameter	Value	Remarks
Channels	8	common ground reference for each 4-channel group, isolated from the other input group
Configuration options	TTL or 24 V input voltage range	configurable at the DSUB globally for 8 Bits: • jumper from LCOM to LEVEL:activates TTL-mode • LEVEL unconnected: activates 24 V-mode
Sampling rate	10 kHz	per channel
Isolation strength	±150 V	tested ±200 V isolated to system ground, supply and untereinander
Input configuration	differential	isolated mutually and from supply
Input current	max. 500 µA	
Switching threshold	1.5 V (±200 mV) 8 V (±300 mV)	5 V level 24 V level
Switching time	<20 µs	
Supply HCOM	5 V max. 100 mA	Reference at level otherwise electrically isolated from system
Terminal connection	DSUB-15	ACC/DSUB(M)-DI4-8

Find here the description of digital inputs 55.

4.11.3 Digital outputs

Technical Details

Parameter	Value		Remarks
Channels / bits	8 bit		Group of 8 bits, galvanically isolated common reference potential ("LCOM“) for each group
Isolation strength	±50 V		to system ground (protection ground)
Output configuration	totem pole (push-pull) or open-drain		configurable at the DSUB globally for 8 Bits: • jumper from OPDRN to LCOM: totem pole • OPDRN unconnected: open-drain
Output level	TTL or max. U_{ext}-0.8 V		internal, galvanically isolated supply voltage by connecting an external supply voltage U_{ext} with "HCOM", U_{ext} = 5 V to 30 V
State following system start	High resistance (high-Z)		Independent of output configuration (OPDRN-pin)!
Activation of the output stage following system start	upon first preparation of measurement		with initial states which can be selected in the experiment (High / Low) in the selected output configuration (OPDRN-pin)
Max. output current (typ.) TTL 24 V-logic open-drain open-drain with intern. 5 V supply	HIGH 15 mA 22 mA --- 	LOW 0.7 A 0.7 A 0.7 A 160 mA	 external clamp diode needed for inductive load for all outputs
Output voltage TTL 24 V-logic (U_{ext} = 24 V)	HIGH >3.5 V >23 V	LOW ≤0.4 V ≤0.4 V	for load current: I_{high} = 15 mA, I_{low} ≤ 0.7 A I_{high} = 22 mA, I_{low} ≤ 0.7 A
Internal supply voltage	5 V, 160 mA (isolated)		available at contacts
Switching time	<100 µs		
Terminal connection	1x DSUB-15 / 8 Bit		ACC/DSUB(M)-DO8

The description of the digital outputs 57.

4.11.4 Incremental encoder channels

Technical Data Sheet

Parameter	Value		Remarks
Channels	4 + 1 (5 tracks)		Four single-tracks or combining two single- into two-track encoders One index track
Measurement modes	Displacement, Angle, Events, Time, Frequency, Velocity, RPMs		
Sampling rate	50 kHz		per channel
Time resolution of measurement	31.25 ns		Counter frequency: 32 MHz
Data resolution	16 bits		
Input configuration	differential		
Input impedance	100 kΩ		
Input voltage range	±10 V		(differential)
Common mode input range	min. -11 V	max. +25 V	
Switching threshold	-10 V to +10 V		selectable per channel
Hysteresis	min. 100 mV		selectable per channel
Analog bandwidth	500 kHz		-3 dB (full power)
Analog filter	Bypass (no Filter), 20 kHz, 2 kHz, 200 Hz		selectable (per-channel) 2nd order Butterworth
Switching delay	500 ns		Modulation: 100 mV squarewave
CMRR	70 dB 60 dB	50 dB 50 dB	DC, 50 Hz 10 kHz
Gain uncertainty	<1 %		of input voltage range @ 25 °C
Offset uncertainty	<1 %		of input voltage range @ 25 °C
Overvoltage strength	±50 V		to system ground
Sensor supply	+5 V, 300 mA		not isolated (reference: GND, CHASSIS)
Terminal connection	DSUB-15		ACC/DSUB(M)-ENC4

The description of the incremental encoder channels 59.

4.11.5 Analog outputs

Technical Data Sheet

Parameter	Value typ.	min. / max.	Remarks
Channels	4		
Output level	±10 V		
Load current	max. ±10 mA / channel		
Resolution	16 Bit		
Non-linearity	±2 LSB	±3 LSB	
Max. output frequency	50 kHz		
Analog bandwidth	50 kHz		-3 dB, low pass 2. order
Gain uncertainty	<±5 mV	<±10 mV	-40 °C to 85 °C
Offset uncertainty	<±2 mV	<±4 mV	-40 °C to 85 °C
Terminal connection	DSUB-15		ACC/DSUB(M)-DAC4

The description of the analog outputs 65.

4.11.6 CAN-Bus Interface

Parameter	Value	Remarks
Number of CAN-nodes	2	each node is galvanically isolated (for each CAN IN and CAN OUT)
Terminal connection	2x DSUB-9	
Transfer protocol	CAN High Speed (max. 1 MBaud, conforming ISO 11898) CAN Low Speed (max. 125 KBaud, conforming ISO 11519)	default switchable per software for each node
Baudrate	1 MBit/s ... 5 kBit/s	selectable via software, maximum for each selected protocol (High/Low Speed)
Max. cable length at data transfer rate	25 m at 1000 kBit/s 90 m at 500 kBit/s	CAN High Speed cable delay 5.7 ns/m
Termination	124 Ω	switchable by software for each node
Isolation strength	±50 V	to system ground (protection ground)
Direct parameterize of imc CANSAS modules	yes	via CAN node of the devices with imc STUDIO, imc DEVICES alternatively imc CANSAS software

Find here the pin configuration and the cabling 65 of the CAN-Bus interface.

4.11.7 Synchronization and time base

Parameter	value typ.	min. / max.	Remarks
Time base per device without external synchronization			
balanced (default)		±50 ppm	at 25°C (accuracy of internal time base)
Drift	±20 ppm	±50 ppm	-40 °C to +85 °C operating temp.
Ageing		±10 ppm	at 25°C, 10 years

Time base per device with external synchronization signal				
Parameter	**GPS**	**DCF77**	**IRIG-B*** **	**NTP*** **
Supported formats	NMEA / PPS*		B002 B000, B001, B003**	version 4 (downwards compatible)
Precision	±1 µs			<5 ms after ca. 12 h
Jitter (max.)	±8 µs			
Voltage level	TTL (PPS*) RS232 (NMEA)	5 V TTL level		---
Input resistance	1 kΩ (pull up)	20 kΩ (pull up)		---
Input connector	DSUB-9 connector non-isolated "GPS"	BNC connector "SYNC" (isolated, depending on the model)		Ethernet
Shield potential input		models with non-isolated BNC connector: system ground models with isolated BNC connector: isolated signal-GND		---

* PPS (pulse per second): signal with an impulse >5ms is necessary ** using BCD information only
*** Not available for devices with serial number less then 140000

Synchronization with DCF77 for several devices (Master/Slave)			
Parameter	**value typ.**	**min. / max.**	**Remarks**
Max. cable length		200 m	BNC cable RG58
Max. number of devices		20	slaves only
Common mode	0 V		with non-isolated BNC connector: devices must have the same ground voltage level, otherwise signal quality problems (signal artifacts and noise) may result. Available optional external isolation: see ISOSYNC
		max. 50 V	with isolated BNC connector: SYNC-signal is already internally isolated, for reliable operation even with different ground voltage level (ground loops)
Voltage level	5 V		
DCF input/output	connector "SYNC"		BNC
Shield potential, DCF input	system ground		see remarks common mode

Isolated SYNC-connection		
Parameter	**value typ.**	**Remarks**
BNC connection	isolated, not connected with housing	marked by a yellow ring around the BNC connector (depending on production date)
Isolation strength	300 V	1 minute
Delay	<100 ns	@ 25°C

ISOSYNC (optional external device for an isolated decoupling of the SYNC signal)			
Parameter	**value typ.**	**min. / max.**	**Remarks**
Isolation strength	1000 V		1 minute
Delay	5 µs		@ 25°C
Temperature range		-35°C to +80°C	

4.12 Miscellaneous

4.12.1 imc Graphics Display

Parameter	Color Display	
Display	5.7″ TFT	
Colors	65536	
Resolution	320 x 240	
Backlight	CCFL	
Orientation	6 o'clock	
Contrast (typ.)	350:1	
Brightness (typ.)	>280 cd/m^2	
Dimensions	192 x 160 x 30 mm, (B x T x H)	
Connection cable	RS232, max. 2 m	
Weight	approx. 1 kg	
Supply voltage	from measurement device or 9 V to 32 V_{DC} 6 V to 50 V_{DC} upon request	
Cable length (DSUB-9)	max. 30 m (acc. RS232 spec.)	
Power consumption	approx. 6.0 W with 100% backlight, imc graphics display 80 approx. 3.6 W with 50% Backlight	
Temperature range	-20°C to +65°C -30°C to +70°C ≤+85°C	operating temperature available upon request module interior temperature
Interconnections	DSUB-9 (female) for connection to measurement device 3-pin Binder (metal) ESTO RD03 series 712, 3-pin for external current supply	
Miscellaneous	150 MHz ARM9 processor, 8 MB Flash, 16 MB RAM, embedded Linux Data transfer from measurement device via BlueTooth (upon request) Membrane touch panel with 15 buttons; robust metal frame Anti-reflection coated glass pane to protect Display	

Description the display 80 and the pin configuration.

4.12.2 ACC/DSUB-ICP ICP-expansion plug

Parameter	Value (min / max)		Remarks
option for	C-10xx, C-12xx, C-41xx, C-50xx, C-60xx, C-70xx		
Inputs	4 2		differential, not isolated ACC/DSUB-ICP4 ACC/DSUB-ICP2
Input coupling	DC ICP		 current source, 1st order high-pass
Current drain per connector		<0.2 A <0.1 A	ACC/DSUB-ICP4 ACC/DSUB-ICP2
Voltage measurement			
Input voltage max. voltage ICP		 ±60 V -3 V to 50 V ±3 V	permanent to chassis at +IN1, ..., +IN2 bzw. +IN4 at -IN1, ..., -IN2 bzw. +IN4
Input impedance voltage ICP	 1 MΩ 10 MΩ 20 MΩ 0.33 MΩ 0.91 MΩ		depending on the measurement ranges of the measurement inputs differential single-ended
ICP™-, DELTATRON®-, PIEZOTRON®-Sensoren[1]			
Highpass cutoff frequency	 3 Hz 1 Hz	 ±20 % ±20 %	-3 dB, AC, corresponding to input impedance of the used measurement input 1 MΩ 10 MΩ, 20 MΩ
ICP-current source	4.2 mA	±10%	
Voltage swing	25 V	>24 V	
Source impedance	280 kΩ	>100 kΩ	

Find here the description of the IEPE (ICP)-expansion plug 68.

4.12.3 ACC/DSUB-ICP2-BNC

Parameter	typ.	min. / max.	Remarks
Compatible channel types	C-10xx, C-12xx, C-41xx, C-50xx, C-60xx, C-70xx		ICP Adapter for BNC to DSUB-15 Amplifiers with four channels per DSUB-15 support channel 1 and 3 only
Inputs	2		single-end, not isolated, BNC ACC/DSUB-ICP2-BNC
Input coupling	ICP		current source, 1st order high-pass
TEDS	conformant to IEEE 1451.4 Class I MMI		sensor with current feed
Measurement with ICP™-, DELTATRON®-, PIEZOTRON®-sensors			
Max. input voltage		±35 V	long-term, to system ground
Input impedance	0.33 MΩ 0.91 MΩ	±5%	depends on input range groups of the measurement inputs used
Ground impedance	145 Ω	±10 Ω	resistance from the BNC shield to the device ground
High-pass cutoff frequency ACC/DSUB-ICP2-BNC	 3 Hz 1 Hz	 ±30 % ±30 %	-3 dB, AC, corresponding to input impedance of the used measurement input 1 MΩ 10 MΩ, 20 MΩ
Constant current	4.2 mA	±10%	
Voltage swing	25 V	>24 V	
Current source internal resistance	280 kΩ	>100 kΩ	in parallel with input impedance

Find here the description of the ACC/DSUB-ICP2-BNC 71.

4.12.4 Technical Specs - ACC/DSUB(M)-ICP2I-BNC

Data Sheet Version 1.2

Parameter	Value typ.	min. / max.	Remarks
Compatible channel types	Bridge amplifier imc CRONOS-device family: DCB2-8, UNI2-8 similar imc C-SERIES devices: Cx-50xx, Cx-70xx		ICP[1] adapter for BNC to DSUB-15 amplifier with four channels each DSUB-15 support only channel 1 and 3
	Voltage amplifier imc CRONOS-device family: ISO2-8, LV3-8 similar imc C-SERIES devices: Cx-12xx, Cx-41xx		
Inputs	2		single-end, isolated, BNC
Input coupling	ICP		current source, 1st order high-pass
Isolation	channel individually isolated		the isolation of each measurement channel depends on the measurement amplifier used (for example each channel of the ISO2-8 is isolated)
Max. sustainable overvoltage		≤50 V	to system ground (CHASSIS) and channel-to.channel
Error indication	LED		Probe breakage recognition
TEDS	imc DEVICES 2.8R5 IEEE 1451.4 conform Class I MMI		sensor with current feed
Measurement with ICP™-, DELTATRON®-, PIEZOTRON®-sensors			
Max. input voltage		<±40 V	between BNC-core and BNC-shielding
Input impedance	0.5 MΩ 8.3 MΩ	>490 kΩ >5 MΩ	depends on input range groups of the measurement inputs used [2]
High-pass cutoff frequency	250 mHz	<1 Hz	-3 dB, corresponding to input impedance of the measurement input used [3]
Constant current	4.2 mA	±10%	
Voltage swing	24 V	>22 V	
Current source internal resistance	340 kΩ	>100 kΩ	in parallel with input impedance

[1] ICP is a registered trade mark of PCB Piezotronics Inc.
DeltaTron is a registered trade mark of Brüel & Kjær Sound and Vibration.
PIEZORON is a registered trade mark of Kistler Instruments.

[2] parallel wiring out of 10 MΩ and input impedance of measurement input in used measurement range

[3] the cut-off frequency as a result of an overlap of an analog and a digital high pass and depends on the input impedance

Find here the description of the ACC/DSUB-ICP2I-BNC. 72

4.12.5 ACC/DSUB-Q2

Data Sheet Version 3.3

Parameter	typ.	min. / max.	Remarks
Usable with module type	bridge amplifier CRC, CRSL, CRPL: DCB-8, DCB2-8, UNI-8, UNI2-8 corresponding devices imc C-SERIES: Cx-50xx, Cx-70xx		module types with 2 channels per DSUB-15 as of imc STUDIO 4.0R1 / imc DEVICES 2.8R3 as of imc STUDIO 4.0R1 / imc DEVICES 2.8R3
	voltage amplifier CRC, CRSL, CRPL: LV3-8 corresponding devices imc C-SERIES: CS-1208-1/-N, CL-1224-1/-N		module types with 4 channels per DSUB-15 as of imc STUDIO 4.0R1 / imc DEVICES 2.8R3 as of imc STUDIO 4.0R1 / imc DEVICES 2.8R3
Inputs	2		differential, non isolated, BNC
Ranges	±100000 pC, ±50000 pC, ±25000 pC, ... ±1000 pC		
Input coupling	- charge AC - charge DC		quasi-static measurements
Max. input voltage Max. charge		±20 V ±200000 pC	related to chassis
Max. common mode voltage		±1 V	voltage between sensor ground and chassis
Bandwidth - lower cut-off-frequency (AC-coupling only) - upper cut-off-frequency (AC- and DC-coupling)	 0.4 Hz 30 kHz 50 kHz		-3 dB range >±10000 pC range ≤±10000 pC
Gain uncertainty	0.2 %	≤1.0 %	of reading
drift	15 ppm/K·ΔT_a	30 ppm/K·ΔT_a	$\Delta T_a = \lvert T_a - 25°C \rvert$ ambient temperature T_a
Offset DC-coupling	 ±6 pC ±1.6 pC	 ≤±30 pC ≤±3 pC	residual charge after reset range >±10000 pC range ≤±10000 pC
drift	 0.006 pC/s 0.003 pC/s	 ≤±0.05 pC/s ≤±0.02 pC/s	mode: DC-Coupling ambient temperature T_a= 25°C ± 20 K range >±10000 pC range ≤±10000 pC
Reset time	300 ms		
Noise	 0.043 pC_{rms} 0.026 pC_{rms} 0.004 pC_{rms}		bandwidth (range = 1000 pC) 0.1 Hz to 10 kHz 0.1 Hz to 1 kHz 0.1 Hz to 100 Hz
Power consumption		≤1 W	supplied by measurement system
Operating temperature		5°C to 60°C	without condensation

Find here the description of the DSUB-Q2 74.

4.12.6 ACC/DSUB-ENC4-IU connector for incremental sensors with current signals

Accessory: connector for incremental sensors with currents signals for use with an incremental encoder interface

Parameter	typ.	min. / max.	Remarks
Inputs	4 + 1		differential, non isolated
Input coupling	DC		
Range 4 basic channels: 1 index channel:	 ±12 µA ±24 µA		
Sensitivity 4 basic channels: 1 index channel:	 -0.2 V/µA -0.1 V/µA		Vout
Input impedance 4 basic channels: 1 index channel:	 200 kΩ 100 kΩ		
Voltage output	differential		differential signal „+Vout“ – „-Vout“ analyzed by the INC-4 module
Output level	approx. 0 V to 5 V +Vout = 2.5 V/µA to 0.2 V/µA -Vout = 2.5 V		basic channels
Analog bandwidth 4 basic channels: 1 index channel:	 80 kHz 50 kHz		
Supply: auxiliary power external sensor	 5 V, 5 mA, 25 mW 5 V, max. 170 mA		supplied by the INC-4 module: DSUB-15 (14) VCC DSUB-15 (7) = GND
Connector plug	DSUB-15 with screw clamp in the connector housing		

Description for incremental sensors with current signals.

4.12.7 ACC/SYNC-FIBRE

Parameter	Value typ.	min./ max.	Remarks
Compatible with	GPS-connection imc measurement device		Modification of the GPS-connection is necessary (device preparation for SYNC-FIBRE). The simultaneous use of both SYNC-FIBRE and the device's SYNC plug (BNC) is not allowed. Only the SYNC-FIBRE or the SYNC plug (BNC) can be used.
Terminal connection	2x ST plug 1x DSUB-9		FOC connection with measurement device
Supply	5 V	±10%	out of device internal sensor supply
Power consumption	0.5 W	±10%	
Propagation Delay tPD	25 ns	75 ns	SYNC-In to Opto-Out or Opto-In to Sync-Out
Link length		500 m	Length of the fiber optic distance between two ACC/SYNC-FIBRE
Total delay		8 µs	SYNC-In first device to SYNC-Out last device
Fiber Optics plug type	ST		
Fiber Optics	50 / 125 µm 62.5 / 125 µm		
Wave length	820 nm		
General			
Extended environmental range	-40°C to + 85°C		with condensation

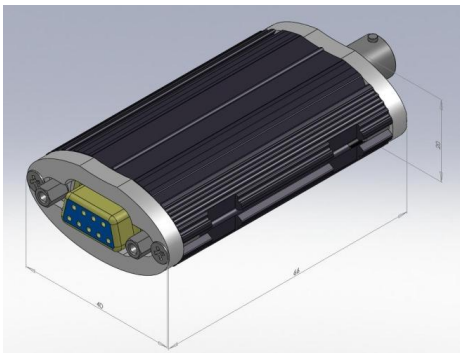
Find here the description of the ACC/SYNC-FIBRE 75.

4.12.8 IRIG-B

Parameter	typ.	min. / max.	Remarks
General			
supported IRIG formats	B120..B127		Amplitude modulated (AM) signal evaluation of BCD-Time-Of-Year and BCD-Year
Input signal amplitude		max. 12 V_{SS} min. 0.8 V_{SS}	Level for mark-period (high) Level for space-period (low)
Input impedance	600 Ω		
Terminal connection	DSUB-9 (female) BNC		for connection with imc device IRIG input
IRIG-input shielding connection	System ground		
Output signal	RS232		Baud rate: 38400, no parity 8N1
Output data format	NMEA 0183		
Delay of the 1 pps-signal	<2 µs		dedicated signal for system clock synchronization of imc device
Jitter of the 1pps-signal	±500 ns		Input signal: 12 V_{SS} without jitter
Supply power consumption	5 V, 70 mA		via DSUB connector
Operating temperature range (standard)	-40°C to +70°C		no condensation
Extended environmental range (optional)	-40°C to +85°C		with condensation
Storage temperature	-40°C to 85°C		
Dimensions	39 x 20 x 60		in mm, W x H x D
Weight	approx. 70 g		
imc article number	1270059		external IRIG-B module

Find here the description of IRIG-B 77.

Is only available for devices of group 5, 6 27



4.12.9 SUPPLY Sensor supply module

Parameter	Value (typ./ max.)			Remarks
Configuration options	5 adjustable ranges			The sensor supply module always got 5 selectable voltage ranges. Default ranges: +5 V to +24 V
Output voltage	Voltage	Current	Netpower	
	(+2.5 V)	580 mA	1.5 W	special order, +12 V can be replaced by +2,5 V
	+5.0 V	580 mA	2.9 W	set globally for all channels of an amplifier.
	+10 V	300 mA	3.0 W	
	+12 V	250 mA	3.0 W	
	+15 V	200 mA	3.0 W	
	+24 V	120 mA	2.9 W	
	(±15 V)	190 mA	3.0 W	special order, +15 V can be replaced by ±15 V
Isolation Standard: option, upon request:	non isolated isolated			output to case (CHASSIS) nominal rating: 50 V, Test voltage (10 sec.): 300 V, not available with option ±15 V.
Short-circuit protection	unlimited duration			to output voltage reference ground
Accuracy of output voltage	<0.25% (typ.) <0.5% (max.) <0.9% (max).			at terminals, no load 25°C 25°C over entire temperature range
Efficiency	typ. 72% typ. 66% typ. 55% typ. 50%			10 V to 24 V none isolated 5 V 10 V to 24 V isolated 5 V
Max. capacitive load	>4000 µF >1000 µF >300 µF			2.5 V to 10 V 12 V, 15 V 24 V

The description of the sensor supply. 73

4.12.10 WiFi (WLAN) Connection

Parameter	Value	Remarks
Data Link Protocol	IEEE 802.11b, IEEE 802.11g IEEE 802.11e IEEE 802.11n WMM	CRFX-2000G (2 antennas)
RF output power	+ 17 dBm +17 dBm (6 – 26 Mbit/s) +15 dBm (48 – 54 Mbit/s)	IEEE 802.11b, IEEE 802.11g **WiFi** certified, Bluetooth coexistance
Receiver sensitivity	-87 dBm (11Mbit/s) -74 dBm (54 Mbit/s)	Ad-Hoc [1] managed [2]
Transfer rate	≤54 Mbit/s	devices with s/n13xxxx, s/n14xxxx, s/n16xxxx and s/n19xxxx delivered as of 01.07.2012 support 54 Mbit/s [3] as of imc DEVICES Version 2.7 R3 SP13 do not downdate those devices with this WLAN connection to an earlier software version
Network type	Ad-Hoc, managed	
Encryption	WEP to 104 Bit WPA-PSK TKIP/RC4 WPA2-PSK CCMP/AES	open system (8 to 63 characters) [2] (8 to 63 characters) [2]
Output frequency	2.402 – 2.480 GHz, ISM band	
Power consumption	1.5 W	

[1] transfer rate <300 kSamples/s, depending on PC hardware configuration

[2] Access Point required

[3] a new dialog in the imc operating software (IF-config) enable the setting of the transfer rate

Find here the description of WiFi (WLAN) connection.

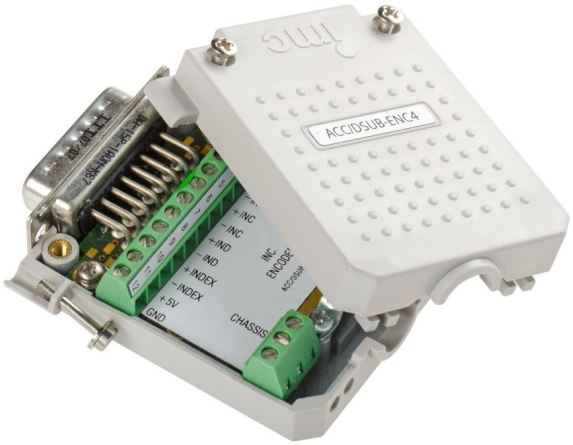
Connectors

5.1 Connecting DSUB-15 adapter plug

The Standard connector 189 is a 1:1 DSUB-15 to screw terminal adapter. It can be used for all modules which come with the corresponding pin configuration. Apart from specific labeling, those connectors are electrically identical.

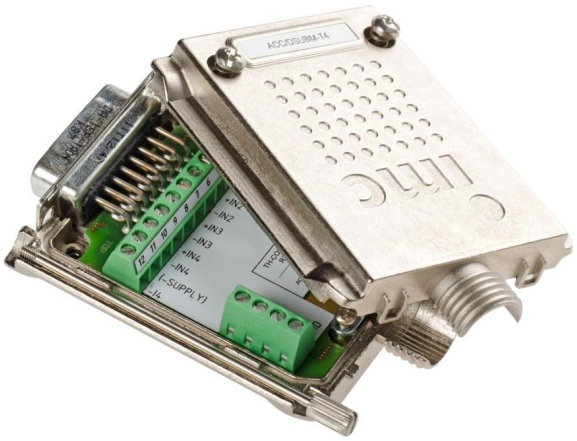
The Special connector 190 do not offer direct adaption from the DSUB pins to the screw terminals, but instead come with extra functions:

For current measurement (up to 50 mA) with voltage channels the Shunt connector 190 (ACC/DSUB(M)-I2 and I4) have a built-in 50 Ω shunt. The scaling factor 0.02 A/V must be set in order to display the current value.



Plastic connector (ACC/DSUB-)

For temperature measurements, a special, patented Thermo connector 190 (ACC/DSUB(M)-T4) is available. This DSUB-15 connector is suited for measurement of voltages as well as temperatures with PT100 and thermocouples with integrated cold junction compensation (CJC). Any types of thermocouples can be connected at the differential inputs (+IN and -IN). It also has additional “auxiliary contacts” for connecting PT100 in 4-wire configurations, where the reference current loop is already pre-wired internally.The Thermo connector can also be used for normal voltage measurement.



Metal connector (ACC/DSUBM-)

The Universal connector 190 (ACC/DSUB(M)-UNI2) contains an additional built-in PT1000 temperature sensor providing cold junction compensation (CJC) for thermocouple measurement. If this function is not required, it is also possible to use a Standard connector for other measurement types.

The ICP connector 190 (ACC/DSUB(M)-ICP2 and ICP4) provide a current supply source as well as a capacitive coupling.

The TEDS connectors 191 are special, TEDS capable (according to IEEE1451.4 for the use with imc Plug & Measure) imc plugs for saving sensor information. The sensor-TEDS are serial PROMS which are connected with an amplifier channel via a digital signal line (One-wire-PROM). For a detailed description of the use of TEDS, see the imc STUDIO User's Manual.

Note on the screw terminals of the connector

To connect the measurement leads with the screw terminals, suitable leads should have a maximum cross section of 1.5 mm2 incl. cable end-sleeve.

The terminals' screw heads only have secure electrical contact once they are tightened to a

connection wire. For this reason, a control measurement (for instance with multimeter probe tips) at "open" terminals can falsely mimic a missing contact!

Cable shielding must be connected at CHASSIS (DSUB frame) as a rule. At some connectors, V_{CC} (5 V) is available, with a maximum load current of typically 135 mA per plug.

5.1.1 Overview of the modules and connectors

imc C-SERIES devices models analog channels

	connector		speed		voltage mode				current		temp		ICP, charge, supply				bridge mode						
device name	channels	connectors	max. sampling rate (per channel)	signal bandwidth (-3dB)	isolated voltage mode	min. voltage range (mV)	voltage up to 10V	voltage up to 50/60V	voltage up to 1000V	20mA internal shunt	20mA shunt plug	Thermocouple (TC)	RTD (PT100)	ICP mode integrated	ICP plug	Charge plug	sensor supply	full bridge	half bridge	quarter bridge	DC excitation	AC excitation (CF)	single SENSE	double SENSE
Voltage Measurement			(Cx-1xxx)																					
CS-1016 [-N]	16	DSUB-15	20 kHz	6,6 kHz		250	●				●				o		o							
CL-1032 [-N]	32	DSUB-15	20 kHz	6,6 kHz		250	●				●				o		o							
CS-1208-1 [-N]	8	DSUB-15	100 kHz	48 kHz		5	●	●			●				o	o★	o							
CL-1224-1 [-N]	24	DSUB-15	100 kHz	48 kHz		5	●	●			●				o	o★	o							
Voltage & Temperature Measurement			(Cx-41xx)																					
CS-4108 [-N]	8	DSUB-15	100 kHz	11 kHz	●	50	●	●			●	●	●		o	o★	o							
CL-4124 [-N]	24	DSUB-15	100 kHz	11 kHz	●	50	●	●			●	●	●		o	o★	o							
Power Measurement (600V CAT III)			(Cx-21xx)																					
CL-2108 [-N]	4 4	Banana Terminal blocks	100 kHz	14 kHz	● ●	2.500 250	● (●)	●	●															
Audio & Vibration Measurements			(Cx-30xx)																					
CS-3008-1 [-N]	8	BNC	100 kHz	48 kHz		5	●	●						●										
CL-3016-1 [-N]	16	BNC	100 kHz	48 kHz		5	●	●						●										
CL-3024-1 [-N]	24	BNC	100 kHz	48 kHz		5	●	●						●										
Noise & Vibration (imc WAVE)			(Cx-80xx)																					
CS-8008 [-N]	8	BNC	50 kHz	22,4 kHz		25	●	●						●										
Bridge & Strain Gauge Measurements			(Cx-50xx, Cx-60xx)																					
CS-5008-1 [-N]	8	DSUB-15	100 kHz	5 kHz		5	●			●	●				o	o	●	●	●	●	●		●	
CL-5016-1 [-N]	16	DSUB-15	100 kHz	5 kHz		5	●			●	●				o	o	●	●	●	●	●		●	
CX-5032-1 [-N]	32	DSUB-15	100 kHz	5 kHz		5	●			●	●				o	o	●	●	●	●	●		●	
CS-6004-1 [-N]	4	DSUB-15	20 kHz	8,6 kHz		5	●	●			●				o	o	(●)	●	●	●	●	●	●	●
CL-6012-1 [-N]	12	DSUB-15	20 kHz	8,6 kHz		5	●	●			●				o	o	(●)	●	●	●	●	●	●	●
For Universal Use			(Cx-70xx)																					
CS-7008-1(-N)	8	DSUB-15	100 kHz	48 kHz		5	●	●		●	●	●	●		o	o	●	●	●	●	●		●	
CL-7016-1(-N)	16	DSUB-15	100 kHz	48 kHz		5	●	●		●	●	●	●		o	o	●	●	●	●	●		●	

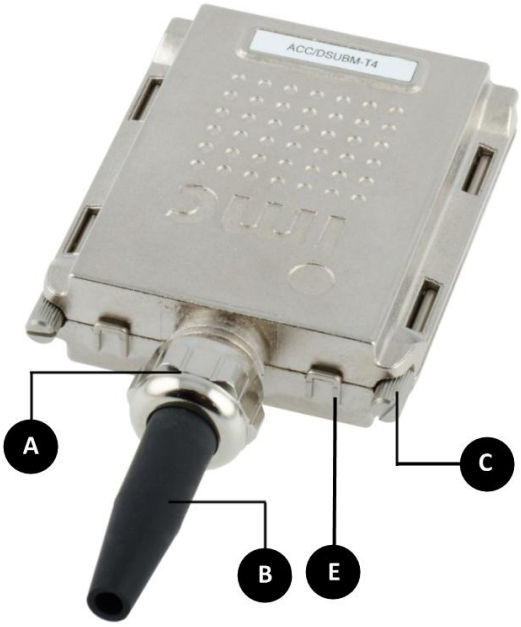
Key: ● default, o optional, (●) restricted, [●] variant, ★ in preparation

Devices with DSUB-15:

imc C-SERIES	Voltage	Current	Bridge	Thermo-couple	current feed sensors IEPE (ICP)	Universal
CS-7008-1 [-N], CL-7016-1 [-N]	UNI2 B2	UNI2 I2	UNI2 B2	UNI2	ICP2	UNI2
CS-5008-1 [-N], CL-5016-1 [-N]	B2 UNI2	I2	B2 UNI2		ICP2	
CS-6004-1 [-N], CL-6012-1 [-N]	B2	I2	B2		ICP2	
CS-1016 [-N], CL-1032 [-N]	U4	I4				
CS-1208-1 [-N], CL-1224-1 [-N]	U4	I4			ICP4	
CS-4108 [-N], CL-4124 [-N]	U4 T4	I4		T4	ICP4	

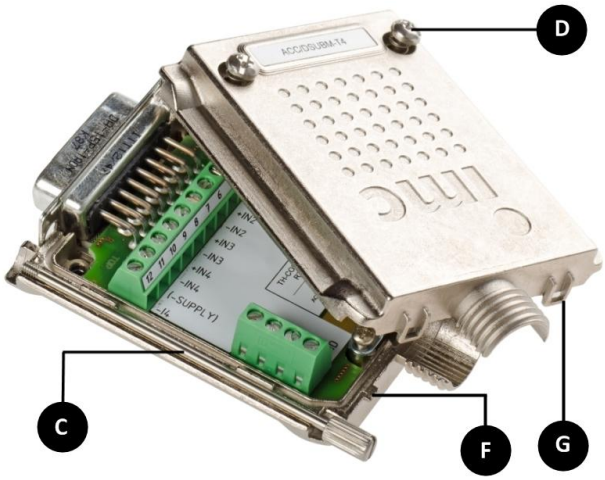
5.2 Metal connector

ACC/DSUBM-xxx



Open the Metal connector:

1. Unscrew the cable fitting (cable gland)
2. Remove the bend protection
3. Unscrew the lid screws
4. Lift the lid in the DSUB connection area and unfasten the nose of the slot



A: Pressure nut
B: Bend protection
C: Fastening screw for the devices' front pa
D: Lid screws
E: Locking key (Nose / Slot)
G: Slot
F: Nose

Close the Metal connector:

1. Assemble the lid by snapping the nose into the slot (see the following picture)
2. Audible click when the lid snaps in the front of the DSUB pod
3. Insert the bend protection
4. The pressure nut must be screwed back on
5. The lid screws can be tightened

5.3 DSUB-15 Pin configuration

5.3.1 Standard and Universal connector

Plastic / Metal connector

ACC/DSUB-		ACC/DSUBM-		B2	U4
DSUB-15 Pin	Terminal	DSUB-15 Pin	Terminal	BRIDGE	VOLTAGE
9	1	9	1	+VB1	(RES.)
2	2	2	2	+IN1	+IN1
10	3	10	3	-IN1	-IN1
3	4	3	4	-VB1	(+SUPPLY)
11	**5**	**11**	**5**	**[+SENSE1_1/4B1]**	+IN2
4	6	4	6	-SENSE1	-IN2
12	7	12	7	+VB2	(-SUPPLY)
5	8	5	8	+IN2	+IN3
13	9	13	9	-IN2	-IN3
6	10	6	10	-VB2	**(GND) ***
14	**11**	**14**	**11**	**[+SENSE2_1/4B2]**	+IN4
7	12	7	12	-SENSE2	-IN4
15	14	15	15	GND	(GND)
8	17	8	18	+5V	(+5V)
	13		13		
	18		14		
Case	15	Case	16	CHASSIS	CHASSIS
Case	16	Case	17	CHASSIS	CHASSIS

[ ] : if SEN-SUPPLY with ±15V option then this pin = -15V

* if SEN-SUPPLY with ±15V option then pin 6 is the reference

Universal connector

Plastic / Metal connector

ACC/DSUB-		UNI2	ACC/DSUBM-		UNI2
DSUB-15 Pin	Terminal	UNIVERSAL	DSUB-15 Pin	Terminal	UNIVERSAL
9	1	+VB1	9	1	+VB1
2	2	+IN1	3	2	-VB1
10	3	-IN1	2	3	+IN1
3	4	-VB1	10	4	-IN1
11	**5**	**I1_1/4B1***	**11**	**5**	**I1_1/4B1***
4	6	-SENSE1	4	6	-SENSE1
12	7	+VB2	5	7	+IN2
5	8	+IN2	13	8	-IN2
13	9	-IN2	**14**	**9**	**I2_1/4B2***
6	10	-VB2	7	10	-SENSE2
14	**11**	**I2_1/4B2***	12	11	+VB2
7	12	-SENSE2	6	12	-VB2
15	14	GND	15	15	(GND)
8	17	+5V	8	18	(+5V)
	13			13	
	18			14	
Case	15	CHASSIS	Case	16	CHASSIS
Case	16	CHASSIS	Case	17	CHASSIS

*** if special version with ±15V option then this pin = -15V**

[]: 1/4 Bridge with Cx-70xx and Cx-50xx and +SENSE with Cx-60xx

Plastic / Metal connector

ACC/DSUB-		ACC/DSUBM-		ENC4, ENC4-IU	DI4-8	DO-8	DAC4
DSUB-15 Pin	Terminal	DSUB-15 Pin	Terminal	INC.-ENCODER	DIGITAL IN	DIGITAL OUT	ANALOG OUT
9	1	9	1	+INA	+IN1	BIT1	
2	2	2	2	-INA	+IN2	BIT2	DAC1
10	3	10	3	+INB	+IN3	BIT3	AGND
3	4	3	4	-INB	+IN4	BIT4	
11	5	11	5	+INC	-IN1/2/3/4	BIT5	DAC2
4	6	4	6	-INC	+IN5	BIT6	AGND
12	7	12	7	+IND	+IN6	BIT7	
5	8	5	8	-IND	+IN7	BIT8	DAC3
13	9	13	9	+INDEX	+IN8		AGND
6	10	6	10	-INDEX	-IN5/6/7/8		
14	11	14	11	+5V	HCOM	HCOM	DAC4
7	12	7	12	GND	LCOM	LCOM	AGND
15	14	15	15		LCOM	LCOM	
8	17	8	18		LEVEL	OPDRN	
	13		13				
	18		14				
Case	15	Case	16	CHASSIS	CHASSIS	CHASSIS	CHASSIS
Case	16	Case	17	CHASSIS	CHASSIS	CHASSIS	CHASSIS

with ENC-4: INDEX only on CON2

5.3.2 Special connector

Plastic

ACC/DSUB-		T4
DSUB-15 Pin	Terminal	TH-COUPLE/RTD
9	1	+I1
2	2	+IN1
10	3	-IN1
	4	+I2
11	5	+IN2
4	6	-IN2
	7	+I3
5	8	+IN3
13	9	-IN3
6	10	-I4
14	11	+IN4
7	12	-IN4
	14	-I2
8	17	-I3
	13	-I1
	18	+I4
Case	15	CHASSIS
Case	16	CHASSIS

Metal connector

ACC/DSUBM-		T4
DSUB-15 Pin	Terminal	TH-COUPLE/RTD
9	1	+I1
3	2	(+SUPPLY)
2	3	+IN1
10	4	-IN1
11	5	+IN2
4	6	-IN2
5	7	+IN3
13	8	-IN3
14	9	+IN4
7	10	-IN4
12	11	(-SUPPLY)
6	12	-I4
	15	-I3
	18	+I2
15	13	GND
	14	+I3
	16	+I4
	17	-I1
	19	-I2
Case	20	CHASSIS

Plastic

Metal connector

ACC/DSUB-		ACC/DSUBM-		I4	I2
DSUB-15 Pin	Terminal	DSUB-15 Pin	Terminal	CURRENT	CURRENT
9	1	9	1	(RES.)	+SUPPLY1
2	2	2	2	+IN1	+IN1
10	3	10	3	-IN1	-IN1
3	4	3	4	(+SUPPLY)	-SUPPLY1
11	5	11	5	+IN2	
4	6	4	6	-IN2	
12	7	12	7	(-SUPPLY)	+SUPPLY2
5	8	5	8	+IN3	+IN2
13	9	13	9	-IN3	-IN2
6	10	6	10	(GND)	-SUPPLY2
14	11	14	11	+IN4	
7	12	7	12	-IN4	
15	14	15	15	(GND)	(GND)
8	17	8	18	(+5V)	(+5V)
	13		13		
	18		14		
Case	15	Case	16	CHASSIS	CHASSIS
Case	16	Case	17	CHASSIS	CHASSIS
			19		
			20		

Plastic

ACC/DSUB-	ICP4	ICP2
Terminal	ICP	ICP
1	+ICP1	+ICP1
2	-ICP1	-ICP1
3	+ICP2	
4	-ICP2	
5	+ICP3	+ICP2
6	-ICP3	-ICP2
7	+ICP4	
8	-ICP4	
9		
10		
11		
12		
14	CHASSIS	CHASSIS
17	+5V	+5V
13	CHASSIS	CHASSIS
18	AGND	AGND
15	CHASSIS	CHASSIS
16	CHASSIS	CHASSIS

Metal connector

ACC/DSUBM-		DO8-HC
DSUB-15 Pin	Terminal	DIGITAL OUT HIGH CURRENT
9	1	BIT1
2	2	BIT2
10	3	BIT3
3	4	BIT4
11	5	BIT5
4	6	BIT6
12	7	BIT7
5	8	BIT8
13	9	HCOM_1-4
6	10	LCOM_1-4
14	11	HCOM_5-8
7	12	LCOM_5-8
15	15	LCOM
8	18	OPDRN
	13	
	14	
Case	16	CHASSIS
Case	17	CHASSIS

5.3.3 TEDS connector

Plastic

ACC/DSUB-TEDS-		U4	B2
DSUB-15 Pin	Terminal	VOLTAGE	BRIDGE
9	1	(RES.)	+VB1
2	2	+IN1	+IN1
10	3	-IN1	-IN1
3	4	(+SUPPLY)	-VB1
11	5	+IN2	**+SENSE1_1/4B1**
4	6	-IN2	-SENSE1
12	7	(-SUPPLY)	+VB2
5	8	+IN3	+IN2
13	9	-IN3	-IN2
6	10	GND*	-VB2
14	11	+IN4	**+SENSE2_1/4B2**
7	12	-IN4	-SENSE2
15	14	TEDS2	GND
8	17	TEDS3	+5V
	13	TEDS1	TEDS1
	18	TEDS4	TEDS2
Case	15	CHASSIS	CHASSIS
Case	16	TEDS_GND	TEDS_GND

* if SEN-SUPPLY with ±15V option then pin 6 is reference

Metal connector

ACC/DSUBM-TEDS-		U4	B2
DSUB-15 Pin	Terminal	VOLTAGE	BRIDGE
9	1	(RES.)	+VB1
3	2	+IN1	+IN1
2	3	-IN1	-IN1
10	4	(+SUPPLY)	-VB1
11	5	+IN2	**[+SENSE1_1/4B1]**
4	6	-IN2	-SENSE1
5	7	(-SUPPLY)	+VB2
13	8	+IN3	+IN2
14	9	-IN3	-IN2
7	10	GND	-VB2
12	11	+IN4	**[+SENSE2_1/4B2]**
6	12	-IN4	-SENSE2
15	15	TEDS_GND	(GND), TEDS_GND
8	18	(+5V)	(+5V)
	13	TEDS1	TEDS1
	14	TEDS2	TEDS2
Case	16	CHASSIS	CHASSIS
Case	17	CHASSIS	CHASSIS
	19	TEDS3	
	20	TEDS4	

[ ] : if SEN-SUPPLY with ±15V option then this pin = -15V

Universal connector

Plastic

ACC/DSUB-TEDS-UNI2		
DSUB-15 Pin	Terminal	UNIVERSAL
9	1	+VB1
2	2	+IN1
10	3	-IN1
3	4	-VB1
11	**5**	**I1_1/4B1***
4	6	-SENSE1
12	7	+VB2
5	8	+IN2
13	9	-IN2
6	10	-VB2
14	**11**	**I2_1/4B2***
7	12	-SENSE2
15	14	(GND)
8	17	(+5V)
	13	TEDS1
	18	TEDS2
Case	15	CHASSIS
Case	16	TEDS_GND

Metal connector

ACC/DSUBM-TEDS-UNI2		
DSUB-15 Pin	Terminal	UNIVERSAL
9	1	+VB1
3	2	-VB1
2	3	+IN1
10	4	-IN1
11	**5**	**I1_1/4B1***
4	6	-SENSE1
5	7	+IN2
13	8	-IN2
14	**9**	**I2_1/4B2***
7	10	-SENSE2
12	11	+VB2
6	12	-VB2
15	15	TEDS_GND
8	18	(+5V)
	13	TEDS2
	14	TEDS1
Case	16	CHASSIS
Case	17	CHASSIS

*** if SEN-SUPPLY with ±15V option then this pin = -15V**

[]: 1/4 Bridge with Cx-70xx and Cx-50xx and +SENSE with Cx-60xx

Plastic

ACC/DSUB-TEDS-T4		
DSUB-15 Pin	Terminal	TH-COUPLE RTD
9	1	+IREF
2	2	+IN1
10	3	-IN1
3	4	
11	5	+IN2
4	6	-IN2
12	7	
5	8	+IN3
13	9	-IN3
6	10	-IREF
14	11	+IN4
7	12	-IN4
15	14	TEDS2
8	17	TEDS3
	13	TEDS1
	18	TEDS4
Case	15	CHASSIS
	16	TEDS_GND

Metal connector

ACC/DSUBM-TEDS-T4		
DSUB-15 Pin	Terminal	TH-COUPLE RTD
9	1	+I1
3	2	(+SUPPLY)
2	3	+IN1
10	4	-IN1
11	5	+IN2
4	6	-IN2
5	7	+IN3
13	8	-IN3
14	9	+IN4
7	10	-IN4
12	11	(-SUPPLY)
6	12	-I4
	15	-I3
	18	TEDS4
15	13	TEDS_GND
	14	+I3
	16	+I4
	17	TEDS3
	19	TEDS2
	20	TEDS1
	21	-I1
	22	+I2
	23	-I2
Case	24	CHASSIS

Plastic

ACC/DSUB-TEDS-		I4	I2
DSUB-15 Pin	Terminal	CURRENT	CURRENT
9	1	(RES.)	+SUPPLY1
2	2	+IN1	+IN1
10	3	-IN1	-IN1
3	4	(+SUPPLY)	-SUPPLY1
11	5	+IN2	
4	6	-IN2	
12	7	(-SUPPLY)	+SUPPLY2
5	8	+IN3	+IN2
13	9	-IN3	-IN2
6	10	(GND)	-SUPPLY2
14	11	+IN4	
7	12	-IN4	
15	14	TEDS2	TEDS_GND
8	17	TEDS3	(+5V)
	13	TEDS1	TEDS1
	18	TEDS4	TEDS2
Case	15	CHASSIS	CHASSIS
	16	TEDS_GND	CHASSIS

Metal connector

ACC/DSUBM-TEDS-		I4	I2
DSUB-15 Pin	Terminal	CURRENT	CURRENT
9	1	(RES.)	+SUPPLY1
2	2	+IN1	+IN1
10	3	-IN1	-IN1
3	4	(+SUPPLY)	-SUPPLY1
11	5	+IN2	
4	6	-IN2	
12	7	(-SUPPLY)	+SUPPLY2
5	8	+IN3	+IN2
13	9	-IN3	-IN2
6	10	GND	-SUPPLY2
14	11	+IN4	
7	12	-IN4	
15	15	TEDS_GND	TEDS_GND
8	18	(+5V)	(+5V)
	13	TEDS1	TEDS1
	14	TEDS2	TEDS2
Case	16	CHASSIS	CHASSIS
Case	17	CHASSIS	CHASSIS
	19	TEDS3	
	20	TEDS4	

5.4 DSUB-9 plugs

5.4.1 CAN-Bus (DSUB-9)

DSUB-PIN	Signal	Description	Use in device
1	nc	reserved	do not connect
2	**CAN_L**	**dominant low bus line**	connected
3	**CAN_GND**	**CAN Ground**	connected
4	nc	reserved	do not connect
5	nc	reserved	do not connect
6	**CAN_GND**	**optional CAN Ground**	connected
7	**CAN_H**	**dominant high bus line**	connected
8	nc	reserved (error line)	do not connect
9	nc	reserved	do not connect

Find here the technical data and the cabling 65 of the CAN-Bus interface.

5.4.2 Display

DSUB-PIN	Signal	Description	Use in device
1	**DCD**	**Vcc 5V**	connected
2	**RXD**	**Receive Data**	connected
3	**TXD**	**Transmit Data**	connected
4	**DTR**	**5V**	connected
5	**GND**	**ground**	connected
6	**DSR**	**Data Set Ready**	connected
7	**RTS**	**Ready To Send**	connected
8	**CTS**	**Clear To Send**	connected
9	**R1**	**Pulldown to GND**	connected

Supply for the graphical display

Connector	+9 V to 32 V	- (0V)	nc
Binder	1	2	3
Souriau	B	C	A

To the description 80 and the technical data of the displays 176.

5.4.3 Modem (extern)

DSUB-PIN	Signal	Description	Use in device
1	**DCD**	**Data Carrier Detect**	**connected**
2	**RxD**	**Receive Data**	**connected**
3	**TxD**	**Transmit Data**	**connected**
4	**DTR**	**Data Terminal Ready**	**connected**
5	**GND**	**Ground**	**connected**
6	**DSR**	**Data Set Ready**	**connected**
7	**RTS**	**Ready To Send**	**connected**
8	**CTS**	**Clear To Send**	**connected**
9	**nc**	**reserved**	**unused**

5.4.4 GPS

With the following wiring, a Garmin GPS-mouse can be connected:

DSUB-9		GPS 18 LVC	GPS 18 - 5Hz
Pin	**Signal**	**Color**	**Color**
1	Vin	Red	Red
2	RxD1*	White	White
3	TxD1	Green	Green
4	-	-	-
5	GND, PowerOff	2x Black	2x Black
6	-	-	-
7	PPS (1Hz clock)	Yellow	Yellow
8	-	-	-
9	-	-	-

* Pin configuration at measurement device. At the GPS-mouse Rx and Tx are interchanged.

5.5 Pin configuration of the REMOTE plug (female)

DSUB-15 Pin: CS-8008	LEMO: CL, CX	Signals at the REMOTE-plug (female)
9	1	OFF
2	2	SWITCH
10	3	ON
3	4	SWITCH1
11	5	-BATT (internal test pin)
mainframe	mainframe	CHASSIS

The description of the REMOTE control 231.

Last changes

6.1 Error remedies in version (2.0 Rev 2)

Smaller changes and layout improvements

	Version currently released	Date of current edition	Version in previous manual	Date of version in the last manual
CS-1016-N and CL-1032-N	V 1.1	2014-01-02	V 1.0	2013-07-17
CS-1208-N and CL-1224-N	V 1.1	2014-01-02	V 1.0	2013-07-17
CS-4108-N and CL-4124-N	V 1.1	2014-01-02	V 1.0	2013-07-17
CS-5008-N and CL-5016-N	V 1.1	2014-01-02	V 1.0	2013-07-17
CS-6004-N and CL-6012-N	V 1.1	2014-01-02	V 1.0	2013-07-17
CS-7008-N and CL-7016-N	V 1.1	2014-01-02	V 1.0	2013-07-17

6.2 Error remedies in version (2.0 Rev 1)

User's manual released 03.01.2014

Topic	Alteration
	no error remedies, minor layout improvements

6.3 Error remedies in version (1.0 Rev 13)

Instruction book released 06.11.2012

Topic	Alteration
	no error remedies, minor layout improvements

6.4 Additions in version (1.0 Rev 12) what is new?

Instruction book released 03.08.2012

Topic	Alteration
SYNC-FIBRE	optical SYNC adapter
DSUB-ICP2I-BNC	isolated measurement of current fed sensors

6.5 Error remedies in version (1.0 Rev 12)

Instruction book released 03.08.2012

Topic	Alteration
	no error remedies

6.5.1 Spec sheet history

	Version currently released	Date of current edition	Version in previous manual	Date of version in the last manual
CS-1016 / CL-1032	V 1.6	02.08.2012	V 1.4	10.02.2011
CS-1208-1 / CL-1224-1	V 1.5	02.08.2012	V 1.3	10.02.2011
CS-5008-1 / CL-5016-1 CX-5032-1	V 1.7	03.08.2012	V 1.5	10.02.2011
CS-7008-1 / CL-7016-1	V 1.7	03.08.2012	V 1.4	10.02.2011

6.6 Error remedies in version (1.0 Rev 11)

Instruction book released 15.02.2011

Topic	Alteration
C/GPS-PRP (1400016)	Ordering a C-series CL-xxxx with option C/GPS-PRP the GPS terminal connection will be suited with GPS function
CL-4108	Bandwidth: 11 kHz (-3 dB) and 8 kHz (-0,2 dB) 101

Technical specifications concerning UPS e.g. internal battery voltage of CS and CL are added.

The chapter overdriving a measurement 54 range is added in this instruction book version.

Note: Smaller changes, e.g. typing errors, and every new chapters are not mentioned in this chapter.

6.6.1 Spec sheet history

	Version currently released	Date of current edition	Version in previous manual	Date of version in the last manual
CS-1016 / CL-1032	V 1.4	10.02.2011	V 1.3	18.06.2010
CS-1208-1 / CL-1224-1	V 1.3	10.02.2011	V 1.2	22.06.2010
CL-2108	V 1.3	10.02.2011	V 1.2	11.05.2010
CS-4108 / CL-4124	V 1.3	10.02.2011	V 1.2	28.05.2010
CS-5008-1 / CL-5016-1 CX-5032-1	V 1.5	10.02.2011	V 1.4	18.06.2010
CS-6004 / CL-6012	V 1.4	10.02.2011	V 1.3	18.06.2010
CS-7008-1 / CL-7016-1	V 1.4	10.02.2011	V 1.3	18.06.2010
CS-8008	V 1.3	10.02.2011	V 1.2	11.05.2010

6.7 Error remedies in version (1.0 Rev 10)

Instruction book released 23.06.2010

Topic	Alteration
CL-2108	The bandwidth is now corrected to 14 kHz (-3 dB).
CS-1208-1	The new measurement system CS-1208-1 is an advanced development of the CS-1208. In this manual version you will find the description of the CS-1208-1 and the CL-1224-1. The manual version 1.0 Rev.9 describes the predecessor device.
C-30xx-1	The new measurement system CS-1208-1 is an advanced development of the CS-1208 and differ not only in the bandwidth. In this manual version you will find the description of the CS-1208-1 and the CL-1224-1. The manual version 1.0 Rev.9 describes the predecessor device.

Correction of the filter characteristics, concerning the following devices:

C-Serie	correct until datasheet version	wrong from version	correct from version
Cx-10	V 1.1 dated 07.04.2009	V 1.2 dated 31.05.2010	V 1.3 dated 18.06.2010
Cx-12-1	neu	V 1.1 dated 14.04.2010	V 1.2 dated 22.06.2010
Cx-50-1	V 1.1 dated 08.05.2009	V 1.2 dated 12.11.2009	V 1.4 dated 18.06.2010
Cx-60	V 1.1 dated 07.04.2009	V 1.2 dated 28.05.2010	V 1.3 dated 18.06.2010
Cx-70-1	V 1.1 dated 07.04.2009	V 1.2 dated 28.05.2010	V 1.3 dated 18.06.2010

Please refer the current datasheet for the accurate filter. The individual module implement different digital filters.

6.7.1 Spec sheet history

Please contact your local distributer for the latest edition of the technical datasheet (PDF).

	Version currently released	Date of current edition	Version in previous manual	Date of version in the last manual
CS-1016 / CL-1032	V 1.3	18.06.2010	V 1.1	07.04.2009
CS-1208-1 / CL-1224-1	V 1.2	22.06.2010	new	
CL-2108	V 1.2	11.05.2010	V 1.1	07.04.2009
CS-4108 / CL-4124	V 1.2	28.05.2010	V 1.1	07.04.2009
CS-5008-1 / CL-5016-1 CX-5032-1	V 1.4	18.06.2010	V 1.2	12.11.2009
CS-6004 / CL-6012	V 1.3	18.06.2010	V 1.1	07.04.2009
CS-7008-1 / CL-7016-1	V 1.3	18.06.2010	V 1.1	07.04.2009

Note

The version number of the technical data has been set back due to a system change. For this reason the version number must be stated in conjunction with the release date.

6.8 Error remedies in Version (1.0 Rev 9)

Instruction book November 12, 2009

No error remedies

Index

µ

µ-Disk 27

A

AAF-filter 66
AC-adapter 18, 19
ACC/DSUB-ICP2-BNC 71
ACC/DSUB-ICP2-BNC technical data 178
ACC/DSUB-ICP2-MICRODOT 71
ACC/DSUB-ICP2-MICRODOT technical data 178
ACC/DSUB-IU: Technical Specs 181
ACC/SYNC-FIBRE 75
aggregate sampling rate 29
aliasing 66
amplitude modulated IRIG signal 77
amplitude response correction
  CL-2108 93
analog outputs 173
angle measurement 49
antialiasing filter 66

B

Balancing
  C-50xx 105
  C-70xx-1 [-N] 124
Bandwidth
  C-30xx-1 [-N] 97
  C-50xx 109
  C-70xx-1 [-N] 132
  CS-1016 [-N], CL-1032 [-N] 81
  CS-1208-1 [-N], CL-1224-1 [-N] 84
  CS-4108 [-N], CL-4124 [-N] 101
batteries 25
BEEPER 75
BR-4: Technical Specs 157
Bridge channels
  C-70xx-1 [-N] 121
bridge channels C-60xx-1 [-N] 111
bridge measurement
  bridge modules 34
  full bridge 34
  half bridge 34
  quarter bridge 34
bridge measurement C-50xx 102
Bridge measurement cable compensation
  C-50xx 104
  C-70xx-1 [-N] 124
bridge-measurement: general remarks 34
buffer duration: maximum (UPS) 24
buffer time constant (UPS) 24

C

C-10xx [-N]
  Bandwidth 81
  Connector 81
  Current measurement 81
  Description 81
  ICP sensors 81
  Shunt-plug 81
  Voltage measurement 81
C-12xx-1 [-N]
  Bandwidth 84
  Connection 84
  Current measurement 84
  Description 82
  ICP sensors 84
  Voltage measurement 82
  Voltage measurement grounded 82
  Voltage measurement with common mode 83
  Voltage measurement with taring 83
  Voltage measurement without ground ref 83
C-30xx-1 [-N] 95
  Bandwidth 97
  Input coupling 95
  input impdance 95
  Voltage measurement 95
  Voltage source with ground reference 96
  Voltage source without ground reference 96
C-30xx-1 [-N] connector 97
C-41xx [-N]
  Bandwidth 101
  Connection 101
  Current measurement 100
  Description 98
  ICP sensors 99
  Input impedance 98
  Pt100 (RTD) - measurement 99

© 2014 imc Meßsysteme GmbH

C-41xx [-N]
Temperature measurement 99
Thermocouple 99
Voltage measurement 98
C-50xx
Balancing 105
Bandwidth 109
Bridge measurement sense 104
Connection 109
Current feed sensors 109
Current measurement 107, 108
Description 102
Initial unbalance 104
Sensor supply 109
Shunt calibration 105
Voltage measurement 106
Voltage source at a different fixed potential 107
Voltage source with ground reference 106
voltage source without ground reference 106
C-60xx-1 [-N]
background quarter bridge 116
bandwidth 118
connection 118
description 110
full bridge 112
half bridge 113
quarter bridge 115
C-60xx-1 [-N] bridge channels 111
C-60xx-1 [-N] Technical data 157
C-70xx-1 [-N]
Balancing 124
Bandwidth 132
Bridge measurement 121
Bridge measurement sense 124
Cable compensation 124
Charging amplifier 132
Connection 133
Current meas. ground ref. 125
Current meas. with var. supply 126
Description 119
DSUB-Q2 132
Full bridge 122
Half bridge 122
ICP and thermocouple 128
ICP sensors 132
Initial unbalance 124
Isolated thermocouple 128
Isoliertes Thermoelement 127
Probe-breakage recognition 130
Pt100 (RTD) - meas. 129
Pt100 in 2 wire config 130
Pt100 in 3 wire config 130
Pt100 in 4 wire config 129
Quarter bridge 123
Sense 124
Sensor supply module 132
Shunt calibration 124
Temperature meas. 127
Thermocouple 127
Thermocouple with ground ref. 127
Thermocouple without ground ref. 128
Voltage measurement 119
Voltage source with CMR 121
Voltage source with ground reference 120
Voltage source without ground reference 120
C-80xx analog inputs technical data 166
Cable compensation
C-70xx-1 [-N] 124
cabling: CAN-Bus 65
calibration resistance 34
CAN-Bus
pin configuration 192
CAN-Bus Interface 174
CAN-Bus: cabling 65
CANSAS 28
carrier frequency amplifier 117
CE Certification 10
Channel assignment: incremental encoder 61
Characteristic curves
Userdefined 132
Charging amplifier 74
C-70xx-1 [-N] 132
CHASSIS 18, 19, 20
circuit schematic: ICP expansion plug 70
CL-2108
amplitude response correction 93
bandwidth 94
current measurement 86
current probe 86
current probe channels 86
current probe connections 93
description 85
high voltage channels 85
input impedance 85

© 2014 imc Meßsysteme GmbH

CL-2108
measurement setup 91
phase response correction 93
Rogowski coil 87
voltage connector 92
voltage measurement 85
CL-2108 technical specification 143
cleaning 18
Close
Metal connector 188
coldjunction compensation 31
color-coding thermocouples 31
Combination mode 43
comparator 60
comparator conditioning: incremental encode 46
connect: CAN-bus to busDAQ 65
Connection
C-41xx [-N] 101
C-50xx 109
C-70xx-1 [-N] 133
CS-1208-1 [-N], CL-1224-1 [-N] 84
Connector
CS-1016 [-N], CL-1032 [-N] 81
Connector compatibility
Cross-Reference 186
connector CS-3008-1 [-N], CL-3016-1 [-N], CL-3024-1 [-N] 97
counter 41, 59
Cross-Reference
Connector compatibility 186
CS-1016 [-N], CL-1032 [-N]
technical specs 139
CS-4108 [-N], CL-4124 [-N]
technical specs 149
CS-5008-1 [-N], CL-5016-1 [-N], CX-5032-1 [-N]
technical data 153
CS-7008-1 [-N], CL-7016-1 [-N] and CS-7008, CL-7016
technical data 161
CS-8008 134
bandwidth 135
connection 135
ICP 135
thirds calculation 134
voltage measurement 134
CS-8008 technical data 166
C-SERIES-N 26
cumulative measurements 44
Current (differential)
C-70xx-1 [-N] 125
Current meas.
C-70xx-1 [-N] 126
Current meas.ground ref.
C-70xx-1 [-N] 125
Current measurement
C-41xx [-N] 100
CS-1016 [-N], CL-1032 [-N] 81
CS-1208-1 [-N], CL-1224-1 [-N] 84
current probe
CL-2108 86
current probe channels
CL-2108 86
current-fed accelerometer: application hints 68
current-fed sensors 53
Cx-12xx analog inputs technical data 141

D

DAC
control functions 65
Datasheet history 196
DCF77 75
DELTATRON 53
desktop power supply unit 18
Device overview 27
differential input: incremental encoder channel 60
differential measurement procedures 44
Digital Inputs 55, 170
input voltage 56
sampling interval 56
Digital Outputs 55, 171
control functions 57
galvanic isolation 57
logic threshold levels 57
open-drain 57
power-up 57
totem-pole 57
DIN-EN-ISO-9001 10
Display 79
pin configuration 192
display variables 79
display: update frequency 80
distance measurement 48
DSUB-Q2 74
C-70xx-1 [-N] 132

© 2014 imc Meßsysteme GmbH

DSUB-Q2: technical specs 180
DSUB-Q2: Technische Daten 182
dual track encoder 59, 61

E

Elastic modulus 40
EMC 12
event-counting 41
events counting 48

F

FCC-Note 12
feed current: ICP-channels 53
filter frequency 30
filter: incremental encoder channels 60
frequency 52
Full bridge
C-50xx 103
C-70xx-1 [-N] 122
full bridge configuration 34
full bridge: 4 active strain gauges 39
full bridge: general 37
full bridge: half bridge - shear strain 39
full bridge: Poisson full bridge (strain gauges adjacent branches) 38
full bridge: Poisson full bridge (strain gauges opposed branches) 38
fuses: overview 25

G

galvanic isolation: supply input 18
General Notes 13
GPS 78
graphics display technical data 176
grounding 18, 21
incremental encoder channel 64
grounding car battery 19
grounding power supply 19
grounding socket 18
grounding: concept 18
grounding: ICP expansion plug 69
grounding: power supply 18
Group 27
guarantee 14
Guide to Using the Manual 9

H

Half bridge
C-50xx 103
C-70xx-1 [-N] 122
half bridge: 1 active and 1 passive starin gauge 37
half bridge: 2 sctive strain gauges 36
half bridge: general 35
half bridge: Poisson 36
half bridge: strain gauge 35
half-bridge configuration 34
hard drive 27
high voltage channels
CL-2108 85
hysteresis: incremental encoder conditioning 60
hysteresis: UPS, take-over threshold 24

I

ICP 53, 95
ICP expansion plug 68
ICP expansion plug: circuit schematic 70
ICP expansion plug: configuration 69
ICP expansion plug: grounding 69
ICP expansion plug: shielding 69
ICP expansion plug: voltage channels 68
ICP sensors
C-70xx-1 [-N] 132
CS-1016 [-N], CL-1032 [-N] 81
CS-1208-1 [-N], CL-1224-1 [-N] 84
CS-4108 [-N], CL-4124 [-N] 99
ICP-channels 68
ICP-channels: application hints 68
ICP-channels: feed current 53
ICP-channels: supply current 53
ICP-channels: voltage channels with iICP expansion plug 68
ICP-expansion plug 177
ICP-expansion plug: Technical specs 177
ICPU-16
Input coupling 95
ICPU2-8 technical data 147
imc Display 80
imcDevices 28
imcStudio 28

© 2014 imc Meßsysteme GmbH

implemented_filters 66
important notes
system setup 14
Incremental Encoder 59, 172
index signal 59
index track 59
sensors 59
incremental encoder channel
sensors with current signals 64
incremental encoder: comparator conditioning 46
incremental encoder: conditioning 60
incremental encoder: maximum input range 44
incremental encoder: scaling 44
incrementalencoder 41
index-channel 47
industrial safety 13
industrial safety regulation 13
Initial unbalance
C-50xx 104
C-70xx-1 [-N] 124
Input coupling
C-30xx-1 [-N] 95
ICPU-16 95
Input impdance
C-30xx-1 [-N] 95
Input impedance
C-41xx [-N] 98
C-50xx 106
C-70xx-1 [-N] 119
input range 30
inputs 30
IPTS-68 30
IRIG-B 77
Isolated thermocouple
C-70xx-1 [-N] 127, 128
ISOSYNC 20, 75

K

K-factor 40

L

leakage: UPS battery 24
LEDs 75
Limited Warranty 10

M

main switch 22
maintenance 14
maximum input range: INC-channels 44
measurement mode: current-fed sensors 53
measurement mode: ICP 53
measurement modes for encoder inputs 41
memory cards 27
Metal connector
close 188
open 188
MICRODOT 71
Modem 75
pin configuration 192

N

NMEA 78
Nyquist frequency 66

O

Open
Metal connector 188
Open-Collector Sensor 63
Overdriving measurement range 54
Overview 26

P

PCB 68
PIEZOBEAM 53
Piezotron 53, 68
pin configuration
CAN-Bus 192
Display 192
Modem 192
Special connector 190
Standard connector 189
TEDS connector 191
pin configuration: REMOTE 23
pin configuration: remote control 193
plug with charging amplifier 74
Poisson half bridge 36
Poisson's ratio 40
power adapter 19

© 2014 imc Meßsysteme GmbH

power cord shielding 20
power supply isolated 19
power supply not isolated 19
power unit 18
Probe-breakage recognition
C-70xx-1 [-N] 130
Product improvement 11
Pt100 31
C-70xx-1 [-N] 129
Pt100 (RTD) - measurement
C-41xx [-N] 99
Pt100 in 2 wire config
C-70xx-1 [-N] 130
Pt100 in 3 wire config
C-70xx-1 [-N] 130
Pt100 in 4 wire config
C-70xx-1 [-N] 129
pulse time 51
PWM mode (INC4) 51

Q

quadrature encoder 59, 61
Quarter bridge 35
C-50xx 104
C-70xx-1 [-N] 123
quarter-bridge configuration 34

R

RAM size 27
receiver: GPS 78
rechargeable batteries 25
rechargeable battery: charging 24
remote control: pin configuration 193
remote switch on 23
Rogowski coil
CL-2108 87
RoHS 10
RPM 52
RS422 63
RTD
C-70xx-1 [-N] 129

S

sampling rate 29
sampling rate: constraints 29
sampling theorem 66
sampling: aggregate sampling rate 29
sampling: concept 59
scaling for strain analysis 40
scaling: incremental encoder 44
scaling: strain gauges 40
Schaltbild: imc-Thermostecker 32
Schmitt-trigger: incremental encoder conditioning 60
Sense 34
C-50xx 104
C-70xx-1 [-N] 124
Sensor supply
C-50xx 109
sensor supply (optional) 73
Sensor supply module
C-70xx-1 [-N] 132
sensors with current signals
incremental encoder channel 64
shielding 18, 20
incremental encoder channel 64
shielding: ICP expansion plug 69
shielding: signal leads 18
Shunt calibration
C-50xx 105
C-70xx-1 [-N] 124
signal leads shielding 20
single signal counter 47
single track encoder 59, 61
single-signal 47
Special connector
DO8-HC 190
ICP2 190
ICP4 190
Pin configuration 190
T4 190
speed 52
Standard connector
B2 189
Pin configuration 189
U4 189
storage temperatures 17
strain gauge: scaling 40
strain gauges 34
SUPPLY technical data 184
supply current: ICP expansion plug 68

© 2014 imc Meßsysteme GmbH

supply current: ICP-channels 53
supply for ICP plugs 73
supply input 19
supply plug 21
supply voltage 21
supply voltage: internal, remote control plug 23
switching device on/off 22
SYNC 75
Sync terminal 75
synchronization 20, 75

T

technical data CL-2108 143
technical data display graphics 176
technical data SUPPLY 184
technical specification: analog outputs 173
Technical specs
CS-1016 [-N], CL-1032 [-N] 139
Technical Specs: BR-4 157
technical specs: Cx-12xx analog inputs 141
technical specs: DSUB-Q2 180
Technical specs: ICP-expansion plug 177
Technical specs: WLAN 185
Technical specs:C-80xx analog inputs 166
Technical specs:CL-2108 143
Technische Daten: DSUB-Q2 182
TEDS 29
TEDS connector
B2 191
I2 190
I4 190
Pin configuration 191
T4 190
U4 191
UNI2 190
Tee-junction 65
temperatur characteristic curve: How to select? 30
Temperature meas.
C-70xx-1 [-N] 127
Temperature measurement 30
C-41xx [-N] 99
temperature table IPTS-68 30
terminators 65
thermo plug 31
Thermocouple
C-41xx [-N] 99
C-70xx-1 [-N] 127
thermocouples 30
thermocouples color-coding 31
Thermostecker: Schaltbild 32
time counter: GPS 78
Time measurement 42, 50
track (X,Y) 59, 61
transport damage 17
transporting 17
two signal encoder 47
two-signal 47

U

uninterruptible power supply 24
UPS 24
UPS: Lead-gel 25
Userdefined characteristic curves 132

V

voltage channels: ICP expansion plug 68
Voltage measuremen
CS-1016 [-N], CL-1032 [-N] 81
Voltage measurement
C-30xx-1 [-N] 95
C-41xx [-N] 98
C-50xx 106
C-70xx-1 [-N] 119
CL-2108 85
CS-1208-1 [-N], CL-1224-1 [-N] 82
Voltage measurement grounded
CS-1208-1 [-N], CL-1224-1 [-N] 82
Voltage measurement with common mode
CS-1208-1 [-N], CL-1224-1 [-N] 83
Voltage measurement with tarierung
CS-1208-1 [-N], CL-1224-1 [-N] 83
Voltage measurement without ground ref
CS-1208-1 [-N], CL-1224-1 [-N] 83
Voltage source with ground reference
C-30xx-1 [-N] 96

W

warm-up phase 14
WEEE
Restriction of Hazardous Substances 10

© 2014 imc Meßsysteme GmbH

WLAN: Technical specs 185
WSGs 34

Y

Y-cable 65

Z

zero marker pulse 59
zero pulse 47

© 2014 imc Meßsysteme GmbH